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not *ethical* but: c.2

note of a reader:

This book has been arround the world — read by me (merchant marine chief Cook) and by a crew member who was blinded by enemy shell explosion while passing ammunition. He can better understand his chances. It is a pitty he won't be given anywhere near as much "pencion" as the "*armed*" forces. He will be "pencioned" untill 5000.00 runs out. Army Navy etc are pensioned well, for life! tis tis — *democracy*! ?

Red or Republican (?)
no Democrat.

Contributions to
a Psychology of Blindness

Contributions to a Psychology of Blindness

by

SAMUEL PERKINS HAYES, PH.D.

1941
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Preface

Within the last decade many teachers in school for the blind have become vitally interested in the contributions psychology may make to the work of the class room and a number of them have attempted to adapt standard achievement and intelligence tests for use with their pupils. Coincident with this has been an awakening in various university graduate schools to the possibility of masters' theses in the rich but untilled fields of research provided by the handicapped. Both groups have suffered because the literature about the blind is so scattered.

Part I of the present volume contains all the chapters thus far completed in a psychology of blindness, arranged from simple to complex in the nature of their content.

They are directed both to the general reading public and to the graduate student and his professor. Here will be found a series of papers covering the work that has been done upon a number of problems in the psychology of blindness with some suggestions concerning the next step in the search.

Part II attempts to make readily accessible to teachers all that has been learned in approximately twenty-five years of testing. It contains discussions of a large number of tests which have been tried out in schools for the blind and gives explicit directions for administering, scoring and interpreting many successful ones. In the appendix two complete bibliographies of test literature upon the blind are offered, one list upon achievement tests and the other upon intelligence tests, including other references along with those of the writer.

The papers in this book have been reprinted practically in their original form but with minor changes and supplementary notes where later knowledge has indicated a need of revision. The articles upon testing have been arranged approximately in chronological order both to show the development of the movement and for convenience in reference. The first two articles of Part II present the methods and results of an early stage in the use of tests with the blind, but are reprinted because they contain discussions of general principles which should constantly be kept in mind in all testing.

PART I

Chapters in the Psychology of Blindness

I

Problems in the Psychology of Blindness

> There is probably no abnormal condition of life so little understood and appreciated and about which so much that is erroneous has been written as blindness.
>
> The very conditions under which the blind live are so extreme and startling that there has gradually been built up about them a world of . . . fairy stories.

This is the opinion of a talented blind author, Clarence Hawkes (5).* The purpose of these chapters on the psychology of blindness is to present a considerable number of these current opinions concerning the blind, to correct or modify them in line with the best experimental work upon the blind thus far published, and to show the many interesting unsolved problems which await the patient application of reliable scientific methods for their proper solution.

Everybody who reads about the blind is familiar with the extravagant claims made about their wonderful accomplishments. This blind man has a marvelous sense of touch, that one an extraordinary acuteness of hearing, this one can sort colors by the slight differences in texture of the fabric or the odor of the dyes, that one has a "facial" sense which saves him from bumping into obstacles in his path; here is a man who can remember the names of a hundred people introduced to him at a reception, there is a man who can read or meditate in the midst of the greatest confusion and excitement, here is another who can grasp, remember, and carry out long lists of complicated directions. And the general reader tends to accept these stories uncritically with a more or less undefined impression that in this way he is giving the blind man his due. Cut off from the use of his eyes, we say, of course a blind person will use his other senses more, and as a result these senses will become keener, and better servants of his will. It is assumed, too, that the blind *must* attend better and remember better because they have to depend upon themselves rather than upon external aids, such as books or memoranda, telephone directories, maps, time tables, dictionaries, and encyclopedias. Thus we pass on to the blind as a class all the tales we hear about unusual individuals who happen to be blind. Having no very intimate acquaintance with the blind, the general reader does not know or remember that there are blind people who have the added handicap of being also deaf; that some blind people have such a poor sense of touch that they cannot learn to read with their fingers at all; that under unfavorable conditions all blind people are likely to run into obstacles, and that most of them would never develop any independence and freedom of movement unless they first adopted a policy of physical bravery with the determination to accept bumps and bruises good-naturedly, and perhaps humorously, as part of the day's work; that some blind people remember very poorly, are easily distracted by disturbing stimuli, are very inferior in reasoning—in other words, that the blind as a group are not prodigies or curiosities but just "folks" like the seeing, some good in one thing, some good in another, probably showing as many degrees of difference among themselves as are found in the larger "class" of the seeing.

---

*References are to volumes listed at end of chapters.

That exaggerated and distorted pictures of the blind appear in general literature is clearly shown in Langworthy's (8) study of the attitudes of authors toward their blind characters. Dr. Best (1) after a careful review of the blind in fiction says:

> Oftentimes the blind are deemed to dwell to a considerable extent in a world away from and beyond that inhabited by ordinary mortals. They are held to be of a less gross and material element than are other persons, and to possess a peculiarly spiritual temperament. They are supposed to be able to respond to certain inner promptings to which others may not be sensitive, and to rise

to unusual esthetic heights. They are frequently thought of as being of an exceedingly docile or tractable disposition, and as being of singularly pure and innocent minds—though now and then, on the other hand, a peculiar viciousness is attached to certain blind characters.

Langworthy (8) suggests a reason for these peculiar views.

> . . . To many a world without light, color, the far view, is an unbearable and even an uncanny place, and it is inconceivable to them that any one can live a life even approaching normal, shut in by the limitations that accompany the loss of the "queen of the senses." The characters in their books show their distorted outlook. Sometimes the blind characters are studied with a degree of care and show some information about the ways of blind people, but usually they embody the feelings of the author—as of the general public—of pity, awe, or idealization of an unknown and little understood condition. Since the blind are already a misunderstood class, each new work of fiction sent out to a credulous public with an unfortunate presentation of a blind character adds to the burden of the misunderstanding and, naturally, the abler and more interesting the book is the more harm it can do to persons already struggling with a major handicap.

The current attitude of the public and the press may be characterized as a combination of pity and wonder based on ignorance; pity which leads to impulsive, ill-directed charity, and wonder which prepares the ground for the growth of fables and fairy tales. Let me quote from Clarence Hawkes (5) on "Some Common Fallacies about Blindness."

> I have had hundreds of people ask me if I could tell color by the sense of touch. How any sensible person could get the idea that it is possible to tell color from the sense of touch is amazing. It is probably partly due to the fact that the public wants to believe all sorts of wild things about the blind, and also because some blind folks, partly in fun and because they like to astonish their friends, have practiced a sort of magic at their expense. I knew a blind horse dealer who could really tell the color of a horse by the sense of feeling, but the color itself had nothing to do with the feat. It was all performed through the fact that different colored horses

had different textured coats. With some colors the hair was fine, while others were coarse; some coats were smooth and others rough.

Most blind people know the colors of the common flowers, and when a friend places a bouquet in your hand you are always able to recognize the flower by either the perfume or the touch, so one can usually make a very good guess as to the color, although in these days of new shades and widely variegated flora even that little artifice is rather dangerous.

It is also a very common question to have seeing people ask the blind if they can tell the denomination of different bills by the sense of touch, and many folks have told me that they knew blind people who could.

There is only one general rule concerning bills that gives any clue at all as to their denomination, and this has so many exceptions as to be entirely worthless.

Bills larger than one dollar are usually printed upon heavier paper than dollar bills—or at least that has been my impression, but the Treasury Department might tell me that even that conclusion is erroneous.

Most blind people carry a pocketbook with several compartments and keep their bills of different denominations in different compartments, so that they know where they are. In that way they can readily make change and give the impression that they can tell bills by the sense of touch.

In the discrimination of coins the blind are not at such a great disadvantage. All except the dime and the penny can be fairly well distinguished by size, and the serrated edge of the dime makes it feel different from the penny.

Of course, no one questions the fact that many blind persons learn to do without eyes many things which would seem to be difficult enough with normal sight. Clarence Hawkes (5) writes:

> There are things that they can do by the sense of touch which are even more remarkable [than telling colors or distinguishing bills], such as threading a needle by placing the end of the thread on the tongue and shoving the head of the needle along until the thread is thrust through the eye, or replacing delicate springs in a

typewriter and keeping the machine in order. I recently successfully adjusted the reproducer on a graphonola which had become discordant.

This is a very delicate piece of mechanism, and its adjustment is usually attempted only by an expert.

But as far as the use of the tongue is concerned, the remarkable thing is that it is *not used more*, since it has the finest touch discrimination of any part of the body. It is practically a magnifying glass for touch. Every reader has doubtless noticed how much larger a cavity in a tooth seems to the tongue than to the finger or to the eye? Blind children occasionally read raised type with the tongue if for some reason their fingers are not sensitive enough. To quote Hawkes further:

> It would seem almost as wonderful for one without the sense of sight to trace the margin on a printed page of a book or newspaper by feeling where the type leaves off and the unprinted page begins. Yet I can do that, while I have known blind people who could read raised print through four thicknesses of a silk handkerchief, or play a piano with a spread placed over the keyboard.
>
> To tell the weight of paper in ream lots within five or ten pounds merely from feeling one sheet would seem to call for a very expert sense of touch, yet that is possible, as well as to tell much about the texture and quality of the paper and how it was prepared for book use.

A little later we shall describe some careful experiments in which blind and seeing subjects were tested along the lines Hawkes describes.

The general public is quite as likely to underestimate as to overestimate the abilities of the blind. As Villey (10) strikingly expresses it:

> Behind those sightless eyes and that face without animation, the first idea is to suppose that everything is dulled, the intelligence, the will, the sensations, and that the faculties of the very soul are numbed and, as it were, stupefied. And then, accustomed as those who see are to doing nothing without using their eyes, it seems to them, very naturally, that if they lost their eyesight, they would

be incapable of any activity, and that their very thoughts would cease to flow through their mind.

An excellent example of the folly to which such an attitude may lead is contained in Hawkes' criticism of what he calls "Mrs. Barclay's amazing portrayals of the condition of blindness."

Readers of *The Rosary* will remember that a crafty Scotch doctor devises the plan of putting in charge of a blind artist, as his nurse, a former sweetheart from whom he has become estranged. While the artist is suspicious of the voice, which reminds him strongly of his friend, although the nurse is using another name, yet he finally succumbs to the subterfuge and is deceived for several weeks until at last she reveals her identity. The entire plot of the story hinges on this deceit.[1]

The fact is that such a deceit would be impossible.

There is as much personality and character in the human voice as there is in the face. It is just as reasonable to say that you would not know your friend by looking on his countenance as that a blind person would not know his friend by the voice, especially when the friend is a sweetheart.

If the voices of a thousand people were tested and analyzed, they would be found to be as individual as the faces of their owners.

I have never in my life met two people whom I could not tell apart by their voices after I came to know them well.[2]

If the voice of the nurse Rosemary had not given her away to her blind artist lover, then there is a mental and spiritual aura surrounding her which would. This sense is very strong between the sexes, and had the young man loved the woman as much as we must believe from the story, even her presence, had she not uttered a word, would have been as apparent to him as the fact that he lived or breathed.

On one occasion the crafty doctor sits in the woods upon a log, with the blind artist on one end of the log and his sweetheart on the other, while he tries to persuade the artist to receive the young lady again into his life.

---

[1] In *Dawn*, by Eleanor Porter, given as a moving-picture play, the same device was used.

[2] Cutsforth (3) claims for the blind an uncanny ability not only to recognize friends but to detect hidden meanings which the speaker has no intention of expressing.

The blind man stands within a few feet of his affinity, yet does not know she is there.

Now the blind are possessed of a sense of perception of solid bodies within a radius of ten or twelve feet which would have told him of this presence had not his aching heart told him in that stead.

But perhaps the most ludicrous of all Mrs. Barclay's imaginings is that whereby the blind artist sits in his library in an easy chair in the middle of the room, with a blue string leading to the piano, a green one to the typewriter, and a yellow string to the bookcase.

To one who without sight is in the habit of going straight to whatever he wants in the house and putting his hand on it without any fuss, of going into the street unattended, hailing a street car, and doing shopping in many stores of the city alone; to one who takes long lecture trips traveling unattended, this sitting in the library with a colored string leading to each piece of furniture is the funniest thing in literature.

Perhaps enough has been said to show the wide differences of opinion and the errors of omission and commission on the part of the general public—which has not had the opportunity to gain intimate knowledge of blind individuals. Strangely enough, one finds the same difference of opinion among superintendents of schools for the blind and employers of blind workers. Of course, such people do not make the elementary mistakes about the use of the senses, mechanical skill, etc. They know what the blind can do and try to inspire them to attain their highest efficiency by demanding the best, assuring them that to win in the struggle with competitors who see they must do their work better than the seeing. But we are all so prone to generalize that we must not be surprised to find persons who have had extended experience with the blind often expressing very decided opinions which have yet to be verified by scientific methods. We hear, for instance, that the blind are generally trustful and cheerful, as the deaf are generally distrustful and jealous; that the blind are difficult to manage in school or in the shop; that they are very cautious in industrial work. On the other hand, we find superintendents of long experience denying the propriety of speaking of the blind as a class. Dr. Burritt (2) says:

> . . . In spite of its frequent use in speech and writing, the phrase "the blind" cannot be used in any generic sense; there is no such concept as "the blind." Persons without sight differ, precisely as those who see, in capabilities, in tastes, in character—in short in all matters that go to make personality. Some have keen intellects, some are dull and almost unteachable; some have a great deal of pride about their personal appearance, others are wholly devoid of an appreciation of its importance; some have strong, sterling characters, others are weak, easily led, and are wholly undependable.

Dr. French (4) carries this proposition much farther.

> To generalize about the blind without first ascertaining the limits of the terms *blind* and *blindness,* as far as these limits are pertinent to the study undertaken, is as dangerous from the educational point of view as are generalizations about any other heterogeneous group. There is, first of all, "no blind as a class," and to think of the blind as such is to miss at once one of the greatest fundamentals of their education: there are blind individuals and small groups of blind people; but at best, "the blind as a class" is simply a convenient collective term. Again, there are all degrees of blindness just as there are varying degrees of deafness, feeblemindedness, and other defects in human physical equipment or mentality. The degree of blindness determines to a very great extent both the intellectual and economic and social possibilities of the individual and the problems to be confronted in his education. Even more important educationally is the age at which blindness begins, the "early-blinded" offering a set of problems quite different in many important respects from the problems offered by those losing their sight after a number of years of incalculable formative and educational value. Lastly, the cause of blindness is exceedingly important; not the mere disease or accident causing blindness, which is of statistical importance chiefly, but its specific effects on the central nervous system, on the remaining senses and on bodily health.

1 X Thus in considering what blindness is, we find three chief lines of differentiation; degree of blindness, age of becoming blind, and the collateral effects of the cause of blindness.

Of course we cannot expect to change our common habits of speech, and we shall continue to discuss "the blind" as we do "the rich" and "the poor". There is plenty of evidence that our economic status affects our behavior and our feelings; in the same sense the handicap of blindness may affect many activities and attitudes. But the uncritical are inclined to generalize beyond the observed facts. Because the blind have a common disability it does not follow that they will also have various other characteristics in common.

In Baldwin's *Dictionary of Philosophy and Psychology*, Dr. Joseph Jastrow (7) writes:

> The serious, thoughtful literature concerning the blind is mainly educational in character and gives an account of the treatment of the blind in past times, of statistics of the frequency, causes and kinds of blindness, of the methods and appliances used in their education, of the management of institutions for the blind, of noteworthy blind persons, and the like. A much more limited series of studies relates to the psychology of the blind as a class. The problems include the effect of the deprivation of sight upon the use and training of the other senses; the precise direction in which the hearing and touch of the blind excel those of the seeing; the mental peculiarities of imagination and association, memory and attention; the influence of blindness upon emotional temperaments and the like. Persons who have been both blind and deaf (and dumb) have naturally attracted considerable attention, and the methods used in their education have furnished valuable illustrations of psychological principles. Some special studies have also been made upon the dreams of the blind.

In spite of this rather discouraging introduction, careful search has revealed a considerable list of books and articles dealing more or less scientifically with the psychology of blindness. The reader must be cautioned, however, to discriminate between what Leta S. Hollingworth (6) has called the "literature of opinion" and the "literature of fact." Mrs. Hollingworth traces the uncertainty concerning the mental differences of the sexes, for instance, to the failure in distinguishing these two types of literature.

> The literature of opinion includes all written statements, made by scientific men and others, not based on experimental evidence. . . . By the literature of fact is meant those written statements based on experimental data, which have been obtained under carefully controlled conditions, and which may be verified by anyone competent to understand and criticize them.

We shall quote from literature of both kinds. The literature of opinion will show us what is commonly thought and said about the blind, and will raise problems for discussion and experimentation. The literature of fact, so far as it has been developed, is the only source for the reliable solution of our problems and constitutes all the genuine "psychology of the blind" that is at present available. Both kinds of literature would be much more valuable, according to Steinberg (9), if writers on the blind knew more psychology and the psychologists knew more about the mental life of the blind.

Steinberg's historical review of the origin and development of interest in the blind will serve as an excellent orientation; it is given here with a few pertinent changes.

> In ancient times the observation that a higher concentration was possible if sensory stimulation was reduced, led to the belief that the outer darkness of the blind might be accompanied by a wonderful inner illumination. Hence poets, minstrels, and seers were deemed fortunate if they were blind and legend has it that Democritus, acting upon this theory, had himself blinded in order the better to carry on his investigations. Most of the blind, however, lived as miserable beggars, showing no trace of inner illumination, so that the occasional gifted individuals among them, who as a matter of fact were generally adult before they lost their sight, were all the more praised and their attainments pointed out in proof of the popular belief.
>
> In the middle ages the situation of the blind was no better: in fact they labored under an added handicap for they were regarded as suffering a special punishment from the Deity, becoming thus a proof of the existence of an all powerful, pitiless judge. Their mental states were considered only in edifying discussions in which they were consoled for their present earthly need by the hope of heavenly bliss.

Blindness first became a topic for scientific discussion at the end of the seventeenth century when students of the problem of space perception sought to explain the relation of tactual to visual space by asking how congenitally blind persons whose sight had been given them through a surgical operation would react to the first objects observed through their eyes. This discussion was begun by Molyneux's question to the English philosopher, John Locke. "Suppose a man born blind, and now adult, and taught by his touch to distinguish between a cube and a sphere . . . so as to tell when he felt the one or the other, which is the cube, which the sphere. Suppose the cube and the sphere placed on a table and the blind man to be made to see: query, whether by his sight, before he touched them, he could distinguish and tell which is the globe, and which the cube"? Molyneux answered "No" and Locke agreed with him. The question was warmly debated upon theoretical grounds and when a few years later it became possible to give sight through surgery to persons with congenital cataract, careful studies were made of the actions and remarks of the patients when first allowed to see. We shall refer to these records extending from Chesselden's case in 1728 to the latest published observations, in our later discussion of space perception.

A wider circle of students now became interested in the blind and various works were written about them, such as Diderot's *Lettre sur les Aveugles à l'usage de ceux qui voient*, (London, 1749). Diderot directed attention to the peculiarities of mental life resulting from the loss of vision, and although he fell into some gross errors (such as the claim that the blind are lacking in modesty and sympathy), his book directed the current of discussion into the wider channel of the total adjustment of the blind to their environment. His positions on various points were hotly contested by the early teachers of the blind, but the arousal of interest in the blind led to the first attempts at their systematic education. In 1784 Haüy began the education of blind children in Paris, and in the early years of the nineteenth century several schools for the blind were established in certain European countries and in the United States.

To combat various common presuppositions concerning the blind, the early teachers of the blind prefaced their books with voluminous introductions in which they described the chief activities of the blind—how they can learn to read embossed print, how they find their way about in strange places, etc.—and attempted an explanation of these surprising achievements by appeal to the ancient belief that the remaining senses were especially quickened to compensate for the loss of vision. The "vicariate of the senses" as it was called, was expressed even in quantitative terms;—reading raised type which demanded a heightened sensitivity of the sense of touch, becomes possible through the release of energy which seeing persons consume in using their eyes. The methods of education were modeled closely upon those used with the seeing instead of being based upon a psychology of the blind. The development of the use of tactual type is an illuminating illustration of this. At first it was thought sufficient to raise the ordinary printed letters and make them a little larger without any regard to the difficulty of analyzing their complicated structure and minor differences through touch. The braille dot system, which was based on a clear appreciation of the limitations of finger reading was for many years neglected.

Besides the vicariate of the senses and the assumed similarity of the spatial ideas attained through sight and touch, the early blind pedagogues discussed also the mental functions which often give the personality of the blind a peculiar character, but their work was limited to the report of carefully observed but isolated details, and lacked systematic conclusiveness, often falling to the level of anecdote.

About the middle of the nineteenth century the blind became the subjects of scientific psychological investigation. At first the fineness of sensory discrimination attracted most attention; more recently the way in which the blind build up their perceptions of space. The higher faculties of the blind have as yet received little attention of a systematic sort, though there are many discussions based on casual observation many of which have been written by authors without vision and without a sufficient scientific background.

A blind man who has made a success in life is quoted as saying, "The blind can do anything but see." Are the blind like the seeing in everything except the loss of vision? Are the assumed differences individual rather than general, i.e., among a thousand blind persons taken at random would you find as many differences in ability and character as you would among a thousand seeing persons taken at random? Are the differences which are supposed to characterize the blind simply the result of a change of interest, training, practice, etc., necessitated by their handicap in the struggle for existence, or does blindness cause the development of new powers and the blossoming of unusual elements in character? Are the blind, as some of them assert, "just *folks* in the dark"?

Science cannot answer questions in bulk. Its first work is always to analyze the complex situation and see how its special technique can be applied to one factor and then to another, in isolation. In the attempt to lay the basis for a psychology of the blind, we must first adopt a scheme of analysis and classification, and then bring together under each head the claims of the blind and the seeing about the blind, and oppose to this all the evidence that we can derive from the scientific literature of fact based on careful experimentation.

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II

Sensory Compensation, or the Vicariate of the Senses

It is a generalization of very long standing that human beings bereft of one sense are compensated by a high development of the senses remaining, and its fallacy has been exposed only at the expense of extensive and careful experimentation. Kitto (24) says that this statement is often made but that he doubts its truth because, in spite of his own loss of hearing, his "visual powers, naturally good, have been subject to all the accidents of advancing time." Levy (26) admits that the truth of the adage "has been more or less denied by those immediately occupied in matters connected with the blind," but seems to favor the belief on theoretical grounds:

> . . . . It is evident that a certain amount of nervous power is exerted by every action of the mind or body. This being so, it is clear that a sighted man expends more nervous power through the medium of the eye than he does in connection with the organs of any other sense. When, however, the sense of sight is wanting, the nervous power usually exerted by it is employed by the other senses. So that the powers of perception enjoyed by a blind man in common with his sighted brethren are more acute than they are under ordinary circumstances; but although this fact mitigates, it does not by any means compensate for the loss of sight. The sense of touch cannot be cultivated as highly in a man who can see as in one who is blind, for the simple reason that whereas the nervous power of the former is diffused through five senses, in the latter it is more concentrated, being diffused through only four senses.

The fallacy of Levy's argument is obvious. His idea of nervous energy as a fixed quantity distributed in some definite amount to the different sense organs is pure fancy, not scientific fact; hence, his reasoning based upon this premise falls to the ground. The passage is quoted as a typical example of the older literature of opinion. Many others may be found in Bürklen, whose book is a treasury of German contributions to the psychology of blindness. A still more extravagant assumption was the claim that one sense might substitute qualitatively for another (serving the real function of a vicar), thus making it possible, according to Whalen (35), for blind persons to get visual impressions through the sense organs of hearing, smell impressions through the sense organs of touch, etc.

Dr. R. H. Babcock (2), a blind physician of Chicago, publishes a very sane discussion giving the modern scientific point of view:

> Most individuals are so helpless in the dark or when their eyes are closed that they very naturally exaggerate the difficulty of doing without sight and often ask blind persons absurd questions. Thus I am often asked how I can enjoy the smoking of a cigar when I cannot *see* the smoke.

The wonderful things blind persons do and the claims of sensory compensation are to be explained, according to this blind man, by acquired sense perception, that is, the training of one sense to take the place of another. Everyone can do this to a certain extent. Anyone can tell with his eyes shut whether he has an orange or an apple in his hand by appealing to the sense of touch or smell. In the case of the blind, necessity motivates an unusual and uncanny development of this sense training. Dr. Babcock continues:

> With blind people it is the senses of touch, hearing, and smell that are especially required to perceive what ordinarily is taken cognizance of by the eyes. Mr. Hawkes has mentioned the apparent recognition of the color of a rose or other flower through the knowledge derived by the odor of the particular flower. It is precisely this sort of thing that enables a blind person to know that a certain flower is on the table, or that a person is in the room when the person is keeping as still as possible, since even when the presence of the person is not betrayed by a perfume he is very apt to

> be betrayed by some other odor insensible to himself. Everybody has a peculiar and, to the sensitive, a *distinguishing* or *characteristic* odor. . . . In my professional work it is this sense of smell that, detecting a particular odor about a patient, has enabled me to tell his occupation, as, for instance, that of a painter or cigarmaker. It is this acquired sense-perception that has often informed me that I was passing a grocery or dry-goods or other store. There is nothing peculiar or wonderful in this when one understands the reason.
>
> Everyone knows that most blind persons possess unusually keen and trained hearing, and it is this keenness or alertness of observation through the ears that enables one without sight to detect what is going on about him or to interpret just what another person in the room is doing. Of course, some blind persons possess a keener power of observation or of interpretation through their remaining senses than have some others. It is, after all, only a matter of training.
>
> But I desire especially to speak of the sense of touch possessed by the blind. Most persons appear to think that touch, or rather the sense of appreciating objects by touch, lies only or mainly in the hand. There is a far finer sense of touch than that, delicate as is the hand or finger. The skin or nerves of the face residing in the skin possess in the *trained* a remarkable sensitiveness, and it was that sort of keenness of sensation of the face that enabled the boy already mentioned to count the trees as he passed, or which permits a blind person to know when he has approached a wall, although undoubtedly sound has more or less to do with it in some instances. Then the feet of the blind acquire a peculiar sensitiveness which enables the individual to recognize locality through peculiarities of the surface on which he is treading. Unevenness in the floor or differences in the thickness or feel of the rugs or carpets, for instance, assist the blind in recognizing just where he is in a room.

An excellent analysis of an actual experience involving surprising use of the sense of hearing by a blind man is given by S. C. Swift (32), Chief Librarian of the Canadian National Institute for the Blind.

> The other day I was standing at a corner waiting for a streetcar. An acquaintance engaged me in conversation till the sound of

an approaching car attracted my attention. I listened for a moment (for cars of two lines used that particular street) and then remarked: "I must leave you now, for I think my car is coming." My acquaintance looked at me in amazement a few seconds and then exclaimed in a tone of mystified wonder, "Oh, those ears!" He did not understand how I distinguished the cars of those two distinct lines, but supposed I was possessed of some occult power beyond the ken of ordinary mortals.

When a street-car approaches a blind man, the fact is first announced by the hiss of the trolley-wheel along the wire; this is followed by the rush of the wheels along the rails, and from this sound the size and weight of the car are easily deduced. Of the two car lines referred to above, one used short, light, single-truck carriages, while those of the other were long, heavy, double-truck vehicles. Each type produced its own distinctive sound, the first somewhat shrill and jerky, the second steady and rumbling. It was a car of this latter type for which I was waiting and which I distinguished far down the street. But these simple facts had entirely escaped the observation of my sighted friend, limited as he was to the experience of visual life, and because of this inattention and its resulting ignorance the blind man, who had seized and pigeonholed these elementary phenomena, was considered a wonder!

M. Kunz (25), the head of an institution for the blind in Germany, was apparently the first person to bring into the discussion of sensory compensation a contribution from the "literature of fact." In his youth, he says, "at an age when you believe everything you read," he came across a statement that in olden times a blind man had been appointed court tailor to a king because he made the most beautiful many-colored clothes for him, being able to distinguish even the finest shades of color by touch.

> . . . . It therefore became an axiom for me that the blind can "feel" colors. In after life, during my activity in middle and higher schools for seeing pupils, I did not fail to make proselytes for my opinion whenever light and heat were spoken of in the instruction in physics, and simply endeavored to seek a plausible explanation of this strange "fact."
>
> I finally thought I had found such an explanation in the vary-

> ing degrees of heat possessed by different colored materials. . . .
> When twenty years ago I exchanged the directorship of a school for seeing pupils for that of an institution for the blind, I likewise harbored among the rest the fairy tale of the ability of the blind "to feel colors," but was soon cured by the blind themselves.

The myth that the blind can distinguish colors by feeling seems to have taken a strong hold on the popular mind, although writers upon the blind have been constantly refuting it for over one hundred years. Villey (33) quotes the following from Garnier's *Treaty of the Faculties of the Mind:*

> . . . . "A blind organist," says Bayle, "was very clever in his profession and he could also distinguish between all sorts of coins and of colours. He played cards and won a great deal, especially when it was his turn to deal, as he knew, by touching the cards, which he gave to each player."

Battles (3), once Principal of the Pennsylvania Institution for the Instruction of the Blind, attributed the persistence of the belief to a number of simple causes. Chicanery—a wilful desire to deceive for personal gain—is illustrated by the case of a blind man in Paris who had an octagonal block of wood, the facets being painted different colors, which he claimed to be able to distinguish by the sense of touch, and did, to the satisfaction of the assembled crowd; but upon examination it was found that some of the facets were smooth while others were rough. The impulse to show off or to tease the credulous public is illustrated by the case of a semi-blind boy who, losing patience at the foolish questions people asked him, claimed he could distinguish colors by smell. When tested, he would carry objects up to his nose and sniff ostentatiously, meanwhile bringing the objects within the range of his very limited vision. False impressions are often drawn by visitors who see blind people at work with different-colored beads, bristles, or wools and falsely assume that the blind can distinguish by some mysterious appreciation of their color. In some cases, doubtless, slight differences in the feeling or smell of fabrics colored with different dyes may serve as a guide in distinguishing them.

Decisive tests were made in 1895 by Ansaldi which showed the impossibility of color-touch by the use of colored pieces of glass. Kunz writes:

> I had also often read and heard that the blind were able to distinguish the most infinitesimal unevenness in a body, which would entirely escape the touch of a seeing person. I consequently expected unreasonable things from the sense of touch of my pupils.

Later, when he was asked to prepare maps for the blind, he says:

> . . . . I was not a little proud to print very sharply defined embossed or raised lines of rivers, cities, and boundaries. I examined the maps with closed eyes, and was able to follow every line with the points of my fingers, which had become hard by the continuous labor of engraving in hard wood. But when I tried to use these maps in the instruction of a class of large intelligent girls . . . the sense of touch failed. They did not find their way on the map. . . .
>
> At that time the maps had been sent for examination to nearly all European institutions for the blind.
>
> Very nearly the same replies were received from all: "Beautiful, but too fine"; "Splendid, but not accessible to touch"; etc.
>
> . . . I had the same experience with zoological and botanical representations, and especially with those used for instruction in physics. Entirely new forms had to be prepared repeatedly before the required accessibility to touch was reached.

His practical experience having contradicted his earlier belief in the compensation of the senses, Kunz then turned to scientific experimental sources. He says he found that a considerable number of scientists had attempted to measure the sensitiveness of touch of a few blind individuals by the use of compass points, and that while the earlier investigators reported a great superiority in the sense of touch of the blind over that of seeing persons, later workers had questioned these results on the ground of the small number of persons examined, the inadequacy of the instruments used, and faults in interpretation. Professor Washburn (34) of Vassar College showed that visualization is an important factor favorable to two-point discrimination, so that even though a blind subject might excel, as hers did, in distinguishing one point from two, the judgment of the *direction* of the points was more successfully accomplished by those seeing subjects who were good visualizers. Steinberg (30) makes further use of the point in reminding us that subjects blinded late in life visualize tactile impressions just as the seeing do, so that the wide variations in individual results may often be due to differences in central response rather than to variations in sensory capacity.

GRIESBACH'S COMPARATIVE STUDY OF THE BLIND AND THE SEEING IN 1899

Although we find a few attempts in the eighties and nineties to measure the auditory and tactual acuity of blind subjects and to make comparisons with the seeing, the results were contradictory, and Kunz was naturally much pleased to open his school to Professor H. Griesbach (12), who in 1899 undertook a comparison of the sensitiveness of the blind and the seeing in their three chief senses—hearing, smell, and touch—with improved instruments and modern experimental methods. As Griesbach's work forms a landmark in the scientific treatment of the subject, we will present it in some detail, quoting freely from Kunz.

Distinguishing the Direction of Sound

Griesbach tested twenty-eight blind and twenty-eight seeing subjects, nine experiments being made with each, three tests with each ear separately and three with both ears together. He found no *essential difference* between the results of the blind and of the seeing. This result was very striking, not only because it contradicted the general opinion of the uninstructed public, but because it was also contrary to the claims of men who had made preliminary experiments. Kunz reports that Professor Marc Dufour, "the well-known oculist," after experimenting upon nineteen blind persons, had made the statement that "blind persons were better able than seeing ones to indicate the direction of sound, and in connection therewith asked the question whether it would not be advisable to appoint blind persons on vessels for accurately determining in foggy weather the direction of signals made by other vessels or the location of landing places[1] . . . ."

Determining the Distance at Which Sounds Can Be Distinguished

In a long corridor, forty-nine seeing and nineteen blind subjects were tested, using as sound stimuli the numbers from 1 to 100 and words of one syllable spoken in a sharp, whispering tone of voice. There was no superiority of the blind over the seeing.

The same thing must be said, according to Kunz, of the musical ear.

> . . . . No experienced teacher of the blind . . . will maintain that the musical ear of the average blind is naturally superior to that of the average seeing person. Only more care is taken in institutions for the blind to develop any talent, by imparting instruction in music to all pupils, and by not dispensing with this instruction until all attempts have failed.

The Acuteness of the Sense of Smell

We have already made reference to the great use of the sense of smell by the blind. This is still more marked in the deaf-blind. G. Stanley Hall (13), a leading American psychologist, long President of Clark University, tested Laura Bridgman's senses of *taste* and *smell*. He reported that she had almost lost her sense of smell during an illness and had never had the habit which so many blind persons acquire of testing objects by applying them to the nostrils. "At present she loves to smell flowers and can distinguish a few of the more fragrant varieties." Experiments with scented objects showed her sensitive only to strong odors. Nor was any special taste sensitivity discovered. She seemed less sensitive to bitter and sour than to sweet and salt.

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[1] A similar suggestion was made during the first World War, the blind being proposed this time as detectors of submarines.

Helen Keller (23) gives a report which reminds one of the testimony quoted above from Dr. Babcock:

> I know by smell the kind of house we enter. I have recognized an old-fashioned country house because it has several layers of odors, left by a succession of families, of plants, perfumes, draperies.
>
> From exhalations I learn much about people. I often know the work they are engaged in. The odors of wood, iron, paint, and drugs cling to the garments of those who work with them. Thus I can distinguish the carpenter from the iron-worker, the artist from the mason or the chemist. When a person passes quickly from one place to another, I get a scent impression of where he has been—the kitchen, the garden, or the sick-room. I gain pleasurable ideas of freshness and good taste from the odors of soap, toilet water, woolen and silk stuffs, and gloves.

Villey quotes the following from M. F. Thomas's account of Marie Heurtin:

> . . . . Her sense of smell is so subtle that by it she recognizes persons before she has had a chance to touch them. It seems as though each individual has a special odour, a distinctive sign, just as each flower has its own perfume, and she is never mistaken in it.[2]
>
> If she is sent to the work-room with a message for one of her companions, she goes at once to the place where her friend is usually to be found. If she should not be there, Marie will stop, turn her head slowly and seek, whilst drawing breath, for the indication she needs. She does not often have to wait long.

Griesbach measured the acuteness of the sense of smell in twenty blind and forty seeing subjects, using the most precise instrument then accessible, Zwaardemaker's olfactometer. Apparently, only one odor stimulus was used—rubber. With this there was no superiority in the average attainment of the blind, but rather a slight inferiority. Of course, one cannot reason from this to the whole range of smell qualities, but the result is significant.

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[2] Donald A. Laird, in an article in the *Journal of Abnormal and Social Psychology,* 29, 1935, 459-561, entitled "Man's Individuality in Odor," cites reports from quite a number of "living persons of distinction" who have a similar ability.

The Acuteness of the Sense of Touch

The popular dogma of the marvelous sense of touch in the blind was supported by some of the early experimental work, but more recent experimenters have questioned the instruments and the methods of their predecessors. Griesbach undertook the exact measurement of the minimal distance at which two stimuli could be distinguished as two, by means of an æsthesiometer of his own in which parallel pins on springs were substituted for the compasses used by earlier workers. With Griesbach's instrument, equality of pressure on the two points could be depended on and, what is still more important, one could stimulate the points more nearly at the same instant. Successive stimuli can be distinguished when much closer together than is the case with simultaneous stimuli, and it is quite possible that the low threshold attributed to the blind by the early workers was due to the neglect of this source of error. Griesbach tested thirty-seven blind and fifty-six seeing subjects, experimenting upon the skin of the forehead, the cheek-bone, the point of the nose, the lips, the thick part of the thumb, and the tips of the fingers. His observations were made partly on holidays, partly after school hours, and partly after instruction in manual work.

At least two important discoveries resulted from this work:

a. He found no evidence that the blind have a more acute sense of touch than the seeing. The experiments with the æsthesiometer gave just the opposite result.

b. Among the blind, the finger used for reading is less able to discriminate points than are the other fingers. From this Kunz surmised that reading blunts the sense of touch,[3] making the finger-ends hard and leathery, and he concluded that this blunting is essential for successful reading.

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[3] The blind organist, David Duffle Wood, gives similar testimony. Although obliged to read braille musical notation, he did not, if he could help it, read braille books, because he wished to keep his sensitivity of touch.

> . . . . *A finger having a very acute sense of touch will also feel the weaker impression of the letters on either side and mix up the letters, i.e.,* not know which points belong to one and the same letter, whilst a finger not possessed of *so acute a sense of touch will hardly take notice of the weaker impressions* produced by the letters on either side. . . .
>
> A seeing person cannot read books printed for the blind *for the reason* that he receives too lively an impression of the points *on either side* and, therefore, *feels too much.*
>
> . . . . Practice makes perfect, and practice in our case means nothing less than the thickening of the epithelium, and the weakening of the sense of touch connected therewith. . . .

From Griesbach's work, Kunz concluded that there is no experimental evidence for a vicariate of the senses as a result of blindness. He refers also to the similar conclusions of two Italian scientists after extended experimental work upon the *deaf*. Dr. Ferrai examined the sense of touch, the "muscle sense," the sensation of pain (caused by the electric current), the sense of smell, and the sense of taste. In his conclusions he laid special stress on the fact that sensory compensation exists as little in the deaf as in the blind. Dr. Rossi expressed the conviction that, to say the least, the strength of sight of the deaf is not superior to that of hearing persons. He also called to mind many cases where deafness and blindness go together.

Kunz continues:

> Thanks to the thorough and conscientious investigations of Griesbach and others, the dogma of the "vicariate of the senses" falls to the ground; . . .
>
> The ruins of the venerable building will probably for many years to come look down into the valley from the sunny heights of pedagogical and other wisdom, but finally time will also level the ruins!

That the ruins have not yet been leveled is evidenced by the fact that we still find articles printed upon the sensory compensation of the blind.

Griesbach published his study in 1899; in 1918 another careful experimental comparison of the blind and the seeing was published by C. E. Seashore (29), Professor of Psychology in the University of Iowa. With Seashore's account we will present the meager experimental literature published since Griesbach's work and the articles since Seashore. A few words from his introduction will show the attitude with which he approached the problem.

SEASHORE'S COMPARATIVE STUDY OF THE BLIND AND THE SEEING IN 1918

> Through years of experience in the laboratory, the conviction has gradually grown upon me that a more radical distinction should be made between sensitiveness and ability to use a sense; i.e., between inborn sensory capacity and acquired ability or skill. From time to time I have taken the opportunity of comparing my own sensitiveness in touch and hearing with that of blind persons distinguished for ability in guiding themselves by hearing and touch; and in no case did I find that the blind persons possessed any significant superiority to myself in sensitiveness to touch and hearing, although some of the blind persons experimented upon were noted for their wonderful performances through hearing and touch.
>
> We finally found an opportunity to put the matter to an accurate and crucial test. Sixteen blind students from the Iowa College for the Blind at Vinton, Iowa, and fifteen pupils from the Iowa City High School were selected as cases for comparison. The ages of the blind ranged from sixteen to twenty-six, and of the seeing from fourteen to nineteen. In selecting the blind, only those were chosen who had been totally blind for more than five years, who were generally otherwise both mentally and physically sound, and were now in high school grades. This resulted in the selection of the ablest pupils in the school. The seeing pupils were taken at random, being selected by the principal on the ground of convenience of schedule. On each of these the following six measurements were made.

Localization of Sound

Griesbach had found no superiority on the part of his blind subjects. Krogius, in 1905, tested twenty blind girls and claimed that their sound localization was more exact than that of seeing subjects. In 1907 he criticized Griesbach's work, performed a new series of experiments using another method, and, on the basis of six thousand measurements, claimed a clear superiority for the blind. In general, he found among the blind only about one-half as many mistakes as among the seeing. Seashore used the latest refinements of apparatus and method, which he describes as follows:

> Discrimination for the direction of sound was measured in terms of the angular displacement in the horizontal plane directly in front of the observer. A click in a telephone receiver served as stimulus. The receiver was mounted at one end of a two-meter bar which was pivoted at the middle and carried a pointer running over a scale of degrees at the other end. This apparatus was mounted at such distance in front of the observer that the receiver moved at the distance of one meter from the center of the head. The click was produced by the rapid make and break of the circuit through the mercury key.

Seashore found the blind slightly superior. The blind varied more than the seeing, however, and the best single record was made by a seeing subject.

Discrimination of the Intensity of Sound

Griesbach had found great individual differences in auditory acuity, but no real inequality between the blind and the seeing as groups. Waidele, in 1905, asserted that not only were there numerous blind persons in whom superior auditory acuity could not be found, but that many suffer from diseased conditions of the ears, and hence have inferior hearing. Kunz, in 1908, tested thirty-eight blind and five seeing subjects with a watch and found the average distance at which the sound was audible for the blind to be 311 cm., and for the seeing 374 cm. Hörter, in 1913, using a tuning fork which was allowed to ring off, came to the same conclusion as Griesbach.

Seashore used a precise instrument of his own invention—an audiometer—in which tones could be produced by a hundred-vibration electro-magnetic fork. Two tones were given successively, and the subject was asked to decide whether the second tone was stronger or weaker than the first. He found no decided superiority either for the blind or for the seeing, and no great differences in variability within the groups. The best record was made by a seeing subject—the same individual who had been most successful in the localization of sound.

Hayes (14) reports a recent study in which the acuity of hearing of ninety-two blind boys, eighty-four blind girls, and nineteen seeing women was determined by the use of a delicate audiometer of the Western Electric Company. No sensory compensation could be discovered when the blind were compared with the seeing. On the whole, the blind did not hear as well. A second study (15) measured the ability of blind and blindfolded seeing subjects to recognize the contents of small boxes through a combination of auditory and muscular cues. When shaken, the small objects in the boxes—nails, coins, tacks, beans, etc.—gave sounds differing in intensity, pitch, and quality, while arousing varied muscular impressions, thus apparently approximating situations in the daily life of the blind. The results showed no clear superiority for either the blind or the seeing in number of trials or number of mistakes per trial while learning the series. But in total time required, the seeing were clearly superior to the blind.

Discrimination of Lifted Weights

Very little attention seems to have been given to the kinæsthetic sensations of the blind except in the experiments with lifted weights. Bürklen (5) cites a few experiments giving contradictory results. Schaefer and Mahner (28), in 1905, tested deaf, blind, and seeing subjects and rated them in order for ability in discriminating between weights, the deaf best, the blind second, and the seeing third.

Seashore used a set of wooden bottles of the same size but varying in weight, arranged on a small revolving table so that any desired weight might be swung into position without noise. The subjects were blindfolded. Seashore found the blind inferior to the seeing. The blind and the seeing showed about the same amount of variability, and the best record was shared by a blind and a seeing subject. There were more extremely poor records among the results for the blind.

A somewhat different type of test with weights was used by Hayes in 1929. In one of the Binet intelligence tests, the subject is asked to arrange in order a series of boxes weighing 3, 6, 9, 12, and 15 gms. respectively. Hayes found the blind clearly inferior to the seeing. In standardizing this test for the seeing, Terman, in 1916, reported that at nine years of age more than 50 per cent of children could pass the test; Hayes found that blind children must be twelve years of age to do as well and therefore moved the test forward to the twelfth year in his 1930 revision for use with the blind.

Discrimination of Passive Pressure

Griesbach had found that on the hands of blind subjects a more intense stimulation was needed to produce a sensation of pressure than was the case with the seeing. This was especially noticeable on the tips of the index fingers, which were often quite unequal in sensitivity.

Stratton, Professor of Psychology in the University of California, in 1903 reported that one of his students had found a decided superiority in the sensitiveness of the blind to slight pressure.

Kunz, in 1907, made an extended examination of twenty blind subjects, using hairs to stimulate various places on the head and the hands. He found such wide variations in different parts of the skin that he despaired of determining a normal pressure threshold. Krogius, in 1907, claims the blind are somewhat superior to the seeing in sensitivity to a hair stimulus.

Seashore used a very delicate pressure balance, which could be adjusted to exert slight pressures on the outer side of the third phalanx of the first finger. The subject was asked to judge whether the second pressure of each pair was stronger or weaker than the first.

Seashore found the blind somewhat superior to the seeing, but also somewhat more variable in their records.

Discrimination in Active Pressure

Griesbach's tests showed Kunz why his fine tactual maps were a failure, and Kunz thought he detected an inverse relationship between active touch and passive touch, for the fingers used in reading tactual type were less sensitive than the other fingers to passive stimulation with the æsthesiometer.

Seashore attempted to compare the efficiency of the blind and the seeing in an unlearned activity involving a use of active pressure similar to its use in everyday life. His plan was to determine under how many thicknesses of paper the position of a wire hair could be located by active exploration with the tip of the first finger. The apparatus consisted of a plate glass disc of 10 cm. in diameter mounted so as to revolve freely. A copper wire about the same diameter as the average human hair was stretched across the plate glass, and the ends firmly fastened. Discs of paper cut from Old Veda Bond were placed over this wire, and the blindfolded observer was required to locate the wire by touch. Starting with ten sheets, five sheets were added for each trial until a failure occurred; then a single sheet was taken off or added till the greatest thickness through which the wire could be located had been determined. The record is therefore given in terms of the number of sheets of paper covering the wire. To one who has not performed the test, the actual results will seem to be very wonderful achievements. In this test much depends upon economic procedure in hunting. The observers were therefore carefully taught how to proceed: e. g., to run the tip of the finger from left to right, and if the wire was not found in that stroke, to run it in a line at right angles to the first; the wire, having been found by this method, was comparatively easy to trace. If it was not found in the first two strokes, these cardinal movements were continued until the observer acknowledged failure. This test seems to measure just the ability which would be used in such activities as detecting the margin of a printed page by touch, reading raised print through several thicknesses of paper, or playing the piano with a cloth spread over the keys, quoted by

Hawkes as examples of the fineness of touch developed by the blind. But Seashore found the blind inferior to the seeing. The average attainment of the blind was 26 sheets, as against an average of 30 sheets for the seeing. The highest blind record was 38 sheets. Four seeing subjects did better than this, finding the wire through 40, 41, 45, and 48 sheets, respectively. The poorest record for the seeing was 18 sheets; for the blind, 10.

Professor Katz (1920), of the University of Rostock, Germany, reports results of experiments with active touch which are no less surprising than Seashore's. When pieces of paper varying in thickness are examined between the thumb and index finger, differences in thickness of 0.01 mm. are clearly distinguished; and when surfaces are explored by the fingers, differences in roughness can be detected when the changes in level actually amount to only a few thousandths of 1 mm. Bürklen (5) suggests that this heightened sensitivity may account for the occasionally reported cases of discrimination of color by touch, the slight tactual differences of various fabrics serving as a cue to the colors with which they are dyed. Katz (22) makes the interesting suggestion that the tactual reading of inkprint by spiritist mediums, which is popularly attributed to the use of occult powers, may be explained by the assumption of a heightened tactual sensitivity in the trance state.

Tactual Space Discrimination

Many comparisons of the blind and the seeing have been made by the method of two-point stimulation. Griesbach thought the blind slightly inferior to the seeing in this test; others found them superior and explained their superiority in terms of practice in touching. Seashore discovered no significant differences between the two groups. He made careful determinations of the two-point threshold on the tip of the first finger and on the inside of the forearm 5 cm. above the wrist. For both groups, the average attainment was 1.3 mm. on the finger-tip and 25 mm. on the arm. Among the blind the best record was 0.6 mm. on the finger-tip, and the poorest record was 2.3 mm. Among the seeing the best record was 0.2

mm. and the poorest 2.1 mm. The seeing made two records that were better than any of the blind records. The average attainment recorded by Seashore for both blind and seeing is quite close to that recorded for the seeing by Griesbach.

In 1925, Brown and Stratton (4), at the University of California, published a study in which a clever mechanical device was used for stimulating two points at a time, and statistical methods were employed in the interpretation of the results. Their æsthesiometer consisted of a board upon which tiny steel posts were arranged in rows an inch apart, over which the subject moved the finger. This device was planned to do away with suggestion and lessen the strain of expectation. The results showed the blind superior to the seeing. In order of efficiency, the totally blind from birth stood highest; next came the totally blind, those partially blind from birth, those partially blind, and last the seeing. These results suggest that their device measured training rather than elementary sensitivity—the training obtained through reading braille with the fingers.

The results obtained by Professor Renshaw (27), of Ohio State University, by a different method, point to the same conclusion. This author found blind adults superior to blindfolded seeing adults in the ability to localize a spot stimulated on the arm by pointing to it with a wooden surgical applicator held in the free hand. But blind children were less successful than blindfolded seeing children. Seeing children apparently use two methods of localizing, tactual-kinesthetic cues and visual cues. Congenitally blind children have only the tactual-kinesthetic cues, but by the time they have grown up become very skilful in their use. Seeing adults, having found visual cues far superior to the others, have come to depend entirely upon the visual cues, and when they are blindfolded are relatively helpless without them.

Taste and Smell Sensitivity

Seashore did not follow Griesbach in testing the blind in *taste* and *smell*, but Mahner in 1909 reported that the blind surpass the deaf in taste and smell discrimination, and that both groups surpass the seeing. Sternberg (31) reports an experiment with a surprising list of subjects—cats, a human anencephalus, some suckling infants, twelve children between eight and fourteen years of age (four blind, four deaf-mutes, and four normal) and certain sick children and adults. He concludes that the mechanism for sharply different reactions to different tastes is established in the human foetus before birth; that cats are highly sensitive to taste and smell differences; that sensitiveness to taste is heightened in gastric disorders; that the lack of sight or hearing improves the differential sensitivity in taste and smell.

Dr. French (9), Superintendent of the California School for the Blind, reports the result of utilizing the blind as expert tasters.

> . . . A trial in one of the great importing houses demonstrated that while the blind may become equal to seeing tasters, the process is one of education, not of increased acuteness. Data regarding the trial of blind tasters were secured directly from members of the firm by the writer. The testimony of 1908 was to the effect that two blind men had been taken on trial and were not proving satisfactory; seeing tasters were very superior, the best being an inveterate "boozer" and smoker, the implication being that not acuteness of the senses of smell and taste but their education was the most important factor. After a lapse of over ten years, another member of the firm reported (1919) that the blind tasters had "made good" and that, he thought, one factor of their success lay in their complete reliance on taste and smell, with no effort to judge quality by sight, aroma being the quality par excellence whereby coffee and tea must be judged.

Sensitiveness to Changes in Temperature

Apparently Kunz did the first experimental work on the sensitivity to *temperature* among the blind. His ten blind and two seeing subjects were asked to hold their hands in two wooden bowls of warm water and after one quarter minute to judge which was warmer. All sensed the difference between 36° and 36.5° C., some depending exclusively upon sensitiveness in the face and others upon sensitiveness from face and hands; no superiority of the blind was established. In later experiments, a deaf-blind subject detected a difference of 0.2° C., and the threshold for the seeing was determined at 0.2°—0.125° C. Krogius, in 1907, found the blind more sensitive than the seeing on the right eyelid. When metal cylinders filled with water at 42° C. were brought near the face, they were detected by the seeing at 13.5 cm., by the blind at 33.7 cm. The cylinders were black and white in alternate longitudinal stripes, and when the cylinders were brought near the face and rotated, the seeing could distinguish between the heat of the black and white stripes only when water of 42° C. was used. The blind could distinguish when the cylinders were empty or when filled with water of room temperature. Wölfflin, in 1908, using Goldscheider's warm and cold metal points on the foreheads of many blind and seeing subjects, found no superiority for the blind.

The Vibratory Sense, Especially in the Deaf-Blind

Shortly after the publication of Seashore's monograph in 1918, the American public was excited by reports of remarkable sensory feats by a blind-deaf girl in a western school for the blind. Crissey (8) writes of an "amazing blind girl who hears by touch and sees by smell." A typical newspaper account (19) follows:

> Fingers that hear and sense of smell that sees are possessed by Wiletta Huggins, aged sixteen, the amazing deaf and blind girl of Janesville, Wisconsin. She hears you through her finger-tips. Though she cannot see you or hear your voice, she divines your presence. She goes to meet a friend across the room as firmly and as surely as if she were normal. She can point out the location in the room of every person she does not know and every friend that may be hidden to decoy her. How she can do it seems as yet inexplicable. If she continues to develop as she has in the past two years, she may be able to teach the scientific world the use of a lost or unknown sense. "Maybe it is a gift of God to reward me for the loss of my sight and hearing" is the girl's only explanation. Wiletta Huggins was brought before the Wisconsin Legislature to display her strange powers a few months ago, and educators,

legislators, physicians, and psychologists all tried to name the secret. All failed. She remained an enigma.

In 1922 Wiletta gave a demonstration of her powers before a large group of Chicago physicians, and the newspapers were full of glowing accounts of the accomplishments of this "Wonder Child" who could "hear with her fingers and see with her nose" when her eyes were completely blindfolded and her ears stopped with cotton wool to prevent the use of any remnant of sight or hearing she might have. She could carry on a telephone conversation with her finger-tips on the receiver; she could respond to words spoken by a person ten feet away when a wooden rod placed on the speaker's head was held in her hand; she could read newspaper headlines and the denomination of bills with her fingers and even describe a photograph by touching it with the end of her nose. Her sense of smell gave similar wonderful results. She could tell the colors of various fabrics by differences in odor, recognize her friends and tell whether strangers liked her, or sort out a group of new bills and return them to the owners after smelling of their hands. Campbell (6) and Hooper (18) give further details.

Apparently, many physicians were inclined to credit Wiletta with the unusual powers she thought she possessed, as was also the psychologist Robert H. Gault (10), who reported the results of his own tests at the meetings of the American Psychological Association in 1922 and then began an extended research on the vibratory senses, in which various normal subjects have been taught to recognize sounds through vibrations received by the finger-tips, with the other conditions so arranged that no stimulation of the ears is possible. But the following vehement protest was lodged by Joseph Jastrow (21), Professor of Psychology in the University of Wisconsin, in the same journal in which Williams (36) had given the opinions of physicians.

> Of course, in every practical sense this girl is blind and has no central vision whatever; but the possibility of a slit-wise vision is by no means excluded. . . . In bringing objects to her nose as if to

> smell them, she has them near enough to her eyes to see them through the slit of vision that she has. . . . Miss Huggins, when tested in the dark room while an ordinary light was on, sorted colors quite correctly though slowly; but with the light extinguished she was unable to do anything at all. . . . The claim . . . put forward that this girl is able to . . . understand spoken language, provided there is a connection between her fingers and the head or larynx of the speaker, either directly or through the medium of a wooden rod (is also beyond belief). . . . It would take far more careful experiments than have yet been made to decide whether this is a case of hysterical deception, . . . but the psychologic laboratory possesses a technic sufficient to determine the matter (whether the girl deceives herself in the belief that the vibrations conveyed through her finger-tips make her hear the sounds which really reach her through auditory channels). When, unknown to the subject (Miss Huggins), the rod that is regarded as essential to carry the vibrations was actually not in contact with the speaker's head, she replied to questions quite as well as though the contact had been established. . . . The reason why Miss Huggins is accredited with these unusual senses is through the conviction that her sight and hearing are useless. My own opportunity to examine Miss Huggins was limited, but was entirely sufficient to convince me that vision of colors was due to the remnant of sight which she retains.

That Jastrow was on the right track seems indicated by the fact that by 1924 the newspapers were reporting a recovery of her lost senses through "mental healing." When examined by some of the same physicians who had tested her before, her vision was pronounced 50 per cent normal, while her hearing was complete in one ear and 50 per cent normal in the other. But they also found that she still retained the superior sensitivity in smell and touch which had attracted attention during her "period of psychic deafness and blindness."

Similar sensitiveness of the deaf-blind to vibrations had often been reported before. Villey (33), for instance, writes:

> . . . The deaf-blind can get endless valuable indications from vibrations. By vibrations alone, they can perceive when a door opens or shuts, and that a drum is being beaten a few yards away

from them. They are aware not only that a troop of soldiers is passing in the street, but also that a person is advancing towards them. By the special tread of a person on the floor, the more clever deaf-blind can even distinguish who the person is, if it be someone to whom they are accustomed.

M. Malossi, who has been blind and deaf from the age of six, is a mechanic at the Naples Blind Institution. It is according to the vibrations, perceived by him in a tactile way, that he works his machinery. By merely placing his hand on the back of the neck of one of his companions, he knows whether the latter is talking or whether he is silent, whether he is laughing or crying. M. Guégan is absolutely deaf, but he assures me that he is sometimes aroused from his sleep by the footstep of a visitor coming into his room. He is, nevertheless, not in touch with the floor, which is perhaps rather shaky, except by means of the legs of the bed.

By touching the exterior organs of speech of the person talking, certain of the deaf-blind manage to follow a conversation.

Helen Keller, for this purpose, places her thumb on the larynx, her forefinger on the lips and her third finger on the edge of one of the nostrils. Professor Stern, when calling on her, was perfectly well understood by her, although his beard and his imperfect pronunciation of the English language were serious obstacles. Then too, several names of persons or places were mentioned in the course of their dialogue. He was present during an easy and rapid conversation, by means of the above method, between Helen Keller and one of her friends.

She knows, and distinguishes by touch, the noise of various machines and the cries of different animals, just as we do by hearing. Still more, she can distinguish different shades in the cries of the same animal. From the mewing to the purring of the cat, she perceives its different ways of expression, and her sensitive muscles do not mistake the angry bark of the dog for the glad bark of welcome.

It goes without saying that she touches musical vibrations by simply placing her hand on an instrument, a piano or a violin. This is a faculty which she shares with many others among the deaf-blind.

Direct contact with the body in vibration is not necessary. When Professor Stern called on Helen Keller, two knocks on the balustrade informed her of the presence of a visitor. During the conversation, she noticed the passing of a train which could be heard in the neighbourhood.

No experimental work upon pain sensitivity among the blind seems to have been published. Organic sensitivity and the sense of equilibrium also appear to have been neglected save for Hall's statement that Laura Bridgman, when tested on a rotating table, showed a normal sense of balance.

As the general result of his own series of experiments, Seashore concluded that there was *no significant constant tendency* in his records proving superiority either for the blind or for the seeing, and our other experimental evidence points in the same direction. "The extraordinary skill in guidance," he says, "through hearing and pressure and other senses in the blind has its basis in apperception rather than in sensation. . . . The person who reads the point print has learned to give meaning to sensory impressions which the seeing person tends to neglect although possessed of the same power as the blind for sensing differences."

Seashore's conclusion had been anticipated by various psychologists and by many scientifically inclined blind people, and when such "literature of opinion" corresponds with the "literature of fact" its quotation seems justified. William James (20) for instance, expressed the truth of the matter in a clear and interesting way many years ago.

That "practice makes perfect" is notorious in the field of motor accomplishments. But motor accomplishments depend in part upon sensory discrimination. Billiard playing, rifle shooting, tight-rope dancing demand the most delicate appreciation of minute disparities of sensation, as well as the power to make accurately graduated muscular response thereto. In the purely sensorial field we have the well-known virtuosity displayed by the professional buyers and testers of various kinds of goods. One man will distinguish by taste between the upper and the lower half of a bottle of old Madeira. Another will recognize, by feeling the flour in a barrel, whether the wheat was grown in Iowa or Tennessee. The blind deaf-mute, Laura Bridgman, so improved her touch as to recognize, after a year's interval, the hand of a person who had once shaken hers; her sister in misfortune, Julia Brace, is said to have been employed in the Hartford Asylum to sort the linen of its multitudinous inmates, after it came from the wash, by her wonderfully educated sense of smell.

Striking instances of the same sort for seeing people were reported still earlier by Carpenter (7). He says:

> It is well known that an extraordinary acuteness of Touch is possessed by the weavers of the finest of those textile fabrics for which India is celebrated. . . . A like improvement is also occasionally noticed in regard to Smell, which may acquire an acuteness rivaling that of the lower animals; and this not only in the blind, but among races of Men whose existence depends upon such discriminative power. Thus we are told by Humboldt that the Peruvian Indians in the darkest night cannot merely perceive through their scent the approach of a stranger whilst yet far distant, but can say whether he is an Indian, European, or Negro. And it is said that the Arabs of the Sahara can recognize the smell of a fire thirty or forty miles distant.

These latter instances make rather a heavy tax on our credulity, and may perhaps be classed with such fantastic stories as that of a blind man who, by means of his superior sense of smell, trailed a Spanish king in the wilderness; of another blind man who could tell anyone in what century his soul arose and what body he occupied in an earlier stage; of the blind leader of a caravan in the desert; of the blind man who steered a ship in a fog!

Thoughtful blind people have long taken the same position that Seashore espouses. Adams (1) cites various groups of seeing persons who do quite as remarkable things as any attributed to the blind—machinists and surgeons, electrical engineers and automobile mechanics—and Swift shows us in detail just how attentive learning, based on the intelligent use of the remaining senses, may accomplish apparent wonders. Swift (32) says:

> The whole surface of the body is like a sensory retina whose countless connecting pathways are so many optic nerves transmitting images to the great center where they become parts of the

conscious life of the individual. Thus, when a blind person goes out upon the street, his ears, his nose, his hand (influenced through his cane), his feet are all so many eyes informing his alert attention as to his whereabouts at any given moment. This is particularly the case when the route is familiar; when the way is new and strange, the blind pedestrian walks with much less confidence, though it must not be supposed that he is wholly at a loss at any time. I shall illustrate with a personal example the all-important part played by attention in assisting a person without sight to move freely along the streets of a city and to determine with precision his exact location in neighborhoods familiar to him from constant residence or frequent visits.

I am spending the evening with a friend who lives one block north and several blocks east of the street where my own home is located. When the time for leave-taking arrives, I bid my friend goodnight and start out on my homeward tramp. What happens? The door closes behind me and I step out upon a short cement-paved path leading to the main sidewalk. Simultaneously with the first contact of my foot with this path the point of my cane strikes the slightly elevated edge of the cement and informs me that I am on my proper side of the walk and at a convenient distance from the edge. The path has a gentle descent until it reaches the street which, by its straight, flat surface, forms with it an exaggerated obtuse angle. The instant my foot falls upon the main sidewalk, I am aware of the fact by the impression that I have ceased to walk down a slope and am now upon the level ground. My cane also warns me that I have reached the street, by meeting the pavement in the angle formed by its intersection with the cement of the path. But during this brief interval another sense than that of touch has been actively engaged in sending messages to consciousness. My ears have been open, for I must know whether any people are moving to and fro upon the sidewalk, and if so, how far they are from me at the moment I issue from the path. This last piece of information is necessary, since it is my intention not to turn and follow the street westward on the north side (that on which my friend's house stands) but to cross to the south and there turn my face in the direction of the setting sun. If my attention tells me that the sound of footsteps, perceived by my auditive sense, indicates that an approaching pedestrian is too close to allow of my passing without a collision, I stop still and wait till the person has passed. If I judge the oncomer to be far enough away, I do not hesitate but cross the walk to the curb. Here again, cane, foot, and ear act in concert, the first two combining with a consciously evoked memory of the fact that, at that particular point, the drop to the roadway is much greater than elsewhere for a considerable distance on either side of it, the latter informing me of the presence or absence of street-cars, motors, or other vehicles. The memory of the sudden drop from curb to pavement causes me to put the point of my cane slightly in advance of my foot, so that it first slips into place over the edge and warns me to be on my guard against a fall. I am thus able to bring my foot to the edge of the curb without fear or hesitation, and, if my ear has declared the way to be clear, I step down upon the road and cross to the south side. On approaching the opposite curb, the slight descent due to the curve of the roadbed makes me aware of the distance yet to be covered, so that at the proper moment, the point of my cane is once more advanced till it meets the obstruction over which my next step carries me to the sidewalk without tripping or stumbling.

Before proceeding farther with this account, it may be well to state that my friend's house is well removed from either corner of the block, a most favorable situation for crossing the street, where blind persons are concerned. As a rule, we prefer to cross a road in the middle of a block, since our attention is therefore not confused by the necessity of taking stock of four converging lines of sound, as would be the case were the crossing made at an intersection. The middle position not only reduces the strain by a half, but it also affords a much better opportunity for judging the relative distances of approaching or receding vehicles by eliminating the disturbing element of cross-sections of corner sounds, if I may be permitted to use such terms in this connection. But to resume:

I have now reached the south side of the street and turned westward. My cane, touching lightly the outer edge of the walk, keeps me in a straight line and assists me to move with quickness and precision. On my left my "sense of presence" tells me there is a high wall by making me conscious of a feeling of slight oppression. This sense also aids in preventing collisions with posts of various kinds planted at intervals along the way. A sudden feeling of relief informs me that the wall has been passed and an open space reached, which my memory knows to be an intersecting street. Instantly I listen in all directions. Attention tells me the way is clear. I cross the road, find the opposite curb in the way already described, and go on block after block, till I reach the corner where I turn south to reach my own street.

At this point something occurs which proves the constant alertness of attention to the slightest impressions from without. I cross the southward-tending street to its western side and proceed a few steps in my original direction till my foot sinks into a small depression so slight as to be scarcely noticeable to the eye, but deep enough to be instantly cognizable to the expectant attention of the blind pedestrian. Without a moment's hesitation, I turn to the left and go forward, for memory, with unerring precision, tells me that this depression is situated almost exactly in the middle line of the walk I must now follow for a block.

Arriving at the corner of my own street (I know it because of the sensation of relief caused by the ending of the row of dwellings close to the sidewalk, and by a low post set in the angle of the intersecting paths against which my cane strikes), I turn once more westward to find my own residence. This is very easy. A short distance from the corner a line crosses my path. I know when this is reached by the fact that my cane meets soft, rutted earth, while my feet tread upon mud left on the pavement by passing wheels. A few paces beyond the lane, a lamp-post stands close to the walk. This familiar landmark encountered, my attention becomes more active than ever, and heeds even more closely than before the impressions conveyed to it through the medium of the cane. I go on till my sensitized wooden guide tells me I have come to the first of two cement walks leading up from the sidewalk; the second is my own and lies only a foot or two beyond the first; I find this second path, step from the street, pass a confirmatory landmark in the shape of a large tree in the angle, take a few steps forward and find himself once more at home.

Villey (33) pictures sensory compensation for vision by the use of an allegory, comparing the blind organism to a workshop which one of the workmen has suddenly left.

. . . He was the most active and the most intelligent of them all; one of those superior workmen, thanks to whose initiative and enterprise everything has been gradually left to him to direct. Undoubtedly, in [the] face of the enormous increase of work which must fall on those who are left, they might be discouraged and let themselves go, so that the output would be less and their wages reduced in consequence. If they are courageous, they can work harder and take advantage of the urgent need felt of them by their master, for improving their material situation. If their comrade, instead of leaving, had simply handed over to them part of the work which was confided to him, the result would have been the same.

Bürklen (5) gives quotations from fifteen writers, from Fricke, 1715, to Wundt, 1910, all of whom explain the sensory superiority of the blind along similar lines, and summarizes the evidence as follows:

> Blindness makes necessary an increased use of the remaining senses. This explains their higher efficiency which is acquired and not congenital. Their superiority rests upon central processes—attention, practice, adaptation—and in extreme cases suggests a physical change.

French (9) writes:

> The common opinion that the loss of one sense renders the others keener has now rather definitely been put to rest. Fairly conclusive experiments and the reliable testimony of blind persons all tend toward the reverse conclusion, namely, that the loss of sight is accompanied by more or less impairment of the remaining senses and not by increased sensitivity. One cannot argue a priori either way. There is actual need of a great deal more of strictly scientific psychological investigation in regard not only to distinctions of differences, but also to absolute threshold of perception, before conclusions approaching finality can be announced.

French further points out that it is particularly the more primitive senses, such as the muscle sense, taste, and smell, which are used in place of vision. This is,

> well illustrated by the ability of the totally blind to follow a trail or path. The sighted person can do the same thing in total darkness; and one remarkable feature of the phenomenon is that he can

accomplish his end much better, if he entirely ceases to attempt to use his eyes. To the observant teacher of the blind there is apparent, often in startling instances, what may not inappropriately be termed a "recrudescence" of the primitive sense life.

Another example, according to French, is seen

> . . . in the ability of the blind to tell the materials out of which a new house is being built. Anyone familiar with building materials can tell by smell the difference between pine and oak; fresh mortar has, too, its characteristic odor. Here again there is no mystery in what is open to all; the seeing person has a surer guide in vision and so neglects what the inferior senses offer him and is guided but little by them. No definite limit can be set to the powers of the senses, because the factor of *educated attention* has no such limit. What the blind person lacks, first in totality of impression and secondly in the acuteness of those impressions that he has, he may make good to a very great extent by attentiveness, conscious or unconscious, to what is given. This applies particularly to the sounds, the interpretation of which is of so much more vital importance to the blind person than to one who can rely on sight. Thus intonation, tricks of speech, and the like, become exceedingly meaningful; the well and the sick voice betray to the blind man the physical condition of one talking to him; and so on through a vast number of gradations, insignificant, because practically useless, to the one with sight. There is increased significance, too, in the texture of a glove, the feel of a handshake, and in personal odors to one who dwells in darkness and must from these very things build up or reconstruct his objective world and his world of social life.

May we now bid a final farewell to the dogma of sensory compensation? Everyone acknowledges that the blind do surprising things with hearing, smell, and touch, but careful measurements do not show that they are superior to the seeing in fineness of sense discrimination. Their attainments must therefore be the result of long-continued, attentive practice: equally surprising feats are performed by the seeing under similar necessity.

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NOTE.—For the contents of a number of articles in German, the writer has been obliged to depend upon Bürklen's *Blindenpsychologie.* Additional references upon hearing, tactual and kinesthetic sensation in the blind may be found in Helga Lende's *Books about the Blind.* New York, American Foundation for the Blind, 1940, 215 pp.

III

Facial Vision, or the Sense of Obstacles[1]

PROBABLY the uncanny ways of the blind have seemed miraculous to the seeing from the beginning of time. The surprising freedom of movement, the avoidance of obstacles in their path, the escape from injury in situations in which vision seems essential, and the inability of the blind themselves to explain exactly how they accomplish these feats have led many observers to attribute to them some mysterious power not shared by the seeing. Many vague descriptive terms have been used to label this special ability, ranging all the way from words and phrases connecting it with the sensory and perceptual life—a sixth sense or an X-sense, a distance sense, sensation of approach, sense of obstacles, the warning sense, and *perceptio facialis,* or facial vision—to words and phrases borrowed from psychical research and occultism—telesthesia, paroptic vision, extra-retinal vision, the sense of presence.

Diderot seems to have been the first person to call the attention of the scientific world to this special ability of the blind in his *Letter on the Blind,* published in 1749.

> The blind man of Puiseaux judges of his nearness to the fire by the degrees of heat; of the fullness of vessels by the sound made by liquids which he pours into them; of the proximity of bodies by the action of air on his face. He is so sensitive to the least atmospheric change that he can distinguish between a street and a closed alley.

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[1] This chapter represents an abbreviated treatment of the subject, based on the author's monograph of the same title published by Perkins Institution, Watertown, Mass. in 1935. There a bibliography of thirty-two titles may be found. Other references appear in Helga Lende's *Books about the Blind,* pp. 63-67.

One of the most striking accounts, showing facial vision in a very high degree, is contributed by W. Hanks Levy in his *Blindness and the Blind*, published in 1872:

> ? Whether within a house or in the open air, whether walking or standing still, I can tell, although quite blind, when I am opposite an object and can perceive whether it be tall or short, slender or bulky. I can also detect whether it be a solitary object or a continuous fence; whether it be a close fence or composed of open rails; and often whether it be a wooden fence, a brick or stone wall, or a quickset hedge. I cannot usually perceive objects if much lower than my shoulder, but sometimes very low objects can be detected. . . . When passing along a street, I can distinguish shops from private houses and even point out the doors and windows, etc., and this whether the doors be shut or open. When a window consists of one entire sheet of glass, it is more difficult to discover than one composed of a number of small panes. . . . When the lower part of a fence is brickwork, and the upper part rails, the fact can be detected, and the line where the two meet easily perceived. Irregularities in height and projections, and indentations in walls, can also be discovered.

Of course not all blind people possess or use this ability to the same degree. Some writers consider it a special talent with which some people are endowed, putting it in the same class with musical, artistic, or mathematical ability; others connect it with the cause of the blindness, certain diseases making the skin especially sensitive to air currents; some think this ability is most likely to appear in those who are born blind or become blind in early infancy, reporting that it is rarely found among adults blinded by accident or in elderly people losing their vision late in life; still others consider it a faculty which can be learned and propose to find out the best methods of developing it so that the obstacle sense may be taught in schools for the blind.

Many interesting theories have been propounded to explain the sense of obstacles, with anecdotes of surprising feats of the blind to support the theories. In 1895, the first thorough-going attempt at a scientific study of the question appeared when Dr. Theodor Heller published his "*Studien zur Blindenpsy-*

chologie" in *Philosophischen Studien,* edited by the great German psychologist, Dr. Wilhelm Wundt. Before this time, most of the evidence for the sense of obstacles was of the hearsay variety, based upon casual observations of a few cases unchecked by scientific controls. The common assumption was ✓ that the blind had some peculiar sensitivity in the skin of the face so that they were made conscious of obstacles in their path by air pressure. When walking, a person pushes before him a column of air, they reasoned. On approaching a solid body, this column of air would be thrown back against its impelling cause and so strike the forehead and face with the effect of a blow, slight or violent according to the height, bulk, line of direction of the object, and the degree of attention paid at the moment by the subject. Blind people reported that when they wore hats pulled down over the forehead, or wrapped pieces of cloth about the face, they had great difficulty in locating objects, and seeing observers noted that many blind people went about with heads pressed forward as if seeking stimulation on the face, thus reminding one of the use of feelers by insects.

Dr. Heller attempted to shed light upon the question by a scientific study along two lines: systematic observation of the ① Heller action of blind people learning to walk about freely in an institution for the blind, and careful experiments with subjects ② who possessed the sense of obstacles. When first attempting to walk without guidance, blind people give one an impression of complete helplessness. Their feet are pushed forward cautiously, while their hands are stretched out to guard them from danger. Gradually, however, they notice changes in the sounds about them and slight sensations in the face as they approach objects, and they learn to restrain their clumsy, groping movements so as to be less conspicuous and so more acceptable to the society of the seeing. No new, mysterious sense is involved, but merely a wise use of pressure and hearing. ✓ Under favorable conditions the blind determine the presence of objects by sound at from 3 to 4 meters, by pressure at from 60 to 70 centimeters.

Dr. Heller writes:

Heller Procedure

> Our experiments were made in a spacious room from which all the furniture had been removed. The 'obstacle' was a school chart, about 1.65 meters by 1 meter, on a stand. In the first series of experiments, touch sensations were eliminated by winding a broad band of flannel about the forehead of the subject and requiring him to keep his hands behind his back. About 45 centimeters in front of the chart, a string was stretched to prevent an actual collision with the obstacle. The chart was set up at various distances in the direction in which the subject was to move, and he was instructed to stop as soon as he had any clue that he was approaching it. In order to keep the subject in a state of concentrated attention, some catch tests were made in which the chart was completely removed. Four subjects took part in the experiments.

In a later series of tests, sensations of hearing were eliminated.

Observation

Certain difficulties appeared in both sets of experiments. In the experiments with a flannel band on the forehead, it often happened that when the chart was not in the room, the subjects asserted with great confidence that they were standing near it; and in other tests, when the chart was at the opposite end of the room, the subjects would stop almost as soon as they had started, saying that, if they stretched out their hands, they could touch the obstacle at once. If the chart was not set perpendicular, but parallel to the line of movement, the subjects were easily deceived, thinking they stood in front of the chart when beside it.

In the experiments with hearing eliminated, other difficulties arose. Sensations within the ear now became very prominent and disturbing. The subjects were unable to move straight forward; and a strip of carpet had to be laid in the direction the experimenter desired them to move. The experiments had to be brief because the sounds within the ear became unbearable.

In summarizing, Heller says:

Summary

> We may now ask ourselves how sensations of sound and touch co-operate in the discovery of obstacles. The damping of the

sound of one's footsteps, resulting from the interference of sound waves, is of course sensed at a greater distance than faint pressure sensations aroused by the reflection of currents of air. And as a result of their greater intensity, the sound stimuli would naturally attract the attention more readily than the touch sensations, which are hardly above the threshold of sensation. Nevertheless, the sound component is not the decisive one in the perception of obstacles. The blind person cannot always tell with certainty from which side the reflected sound comes. He notes modifications in the sound of his footsteps, but this may result from differences in the floor upon which he is walking. The only criterion which is decisive for the presence of obstacles is the pressure sensation obtained on the forehead. But since these sensations are so slight, they would not be noticed unless the attention of the subject had first been directed to them by sensations obtained through the ears. . . . The behavior of the blind when approaching an object may then be explained as follows: the perception of changes in the sound of his footsteps leads to careful attention for sensations of pressure on the forehead. If these characteristic sensations then arise, he is sure that there is an obstacle in his path, and he turns aside in good time. The sound components of the experience serve as a signal which inhibits other processes which might prevent full attention.

At about the time that Heller was experimenting in Germany, three American psychologists became interested in the obstacle sense. William James in 1890 had raised the question whether one might not be conscious of the presence of objects by means of tactile sensations from the tympanic membrane of the ear. Dresslar tested this suggestion by a series of experiments in 1893, and his experiments were repeated in 1904 by Robert MacDougall. Dresslar first used a manometer to determine how sensitive the ear-drums are to atmospheric pressure and concluded that it was a mistake to ascribe to the ear-drums the sensation of being "shut in" when near large objects, since the pressure of the air would not be strong enough to stimulate them. He then turned to an investigation of other possible elements in facial vision, by using a series of frames which were respectively open, latticed, filled with a solid panel of wood, or covered with wire screening. With the eyes closed, his subjects distinguished the four frames very well; they did nearly as well when thermal sensations and "facial vision" were prevented by covering the ear, face, and neck with cloth and cardboard, leaving a hole opposite the auditory meatus. But when the ears were tightly stopped with cotton, there were as many wrong judgments as there were right ones; Dresslar concluded that "the basis of judgment was due to differences in sound". MacDougall confirmed Dresslar's finding that persons with normal sensory equipment and without special training can, when blindfolded, detect the proximity of various frames and, to some extent, distinguish them. But he questioned the predominate role assigned to audition; with his subjects, plugging the ears made practically no difference in the correctness of response, while preventing facial stimulation considerably reduced the ability to perceive the frames.

MacDougall says:

> Every large object by which one passes modifies the movements of the air, cutting off the wind on one side and causing eddies and back-draughts on the other, thereby affecting the sensations of pressure on cheek and brow. It likewise disturbs the local distribution of heat by intercepting the cooling breeze and by absorbing and reflecting the rays of the sun; and by also preventing the free radiation of heat from the body, it may give rise to discriminable differences in temperature sensation. Such an object, finally, disturbs the free propagation of sound waves, intercepting and reducing those coming from one direction and reinforcing by reflection those which come from the other side. Any one of these factors severally, or a combination of them, may conceivably afford the sensational basis upon which the reported perception depends. . . . It thus appears that the process in question is not restricted to any one type of sensory stimulation, but may depend, in different individuals, upon any one of several sources and, in ordinary cases, probably involves a combination of these. That to which, in addition to hearing, I should call attention as likely to play a part in the process, is the sense of temperature. The interference with the normal radiation of heat caused by solid objects in proximity to the skin results in changes of temperature at the surface that are by no means small, and I am inclined to believe

that, if a delicate thermometer were employed to test their fluctuations, the latter would be found to parallel the variations in the proportion of correct and incorrect responses according as the object was made to approach or recede from the skin.

No further serious attempt to study facial vision experimentally seems to have been made until 1903 when Javal brought into use the phrase, "the sixth sense of the blind," which he regarded as similar to touch, but somehow different and more sensitive. Touch is aroused only by objects that come into actual contact with the skin, while the sixth sense, he suggests, is aroused by ether waves, the ultra-violet rays possibly playing a special rôle. Considerable interest was aroused by Javal's theory, and in the immediately following years, quite a series of short articles appeared in scientific magazines and in periodicals like *Der Blindenfreund.* Hauptvogel in 1906, for instance, following Javal's lead, suggested that the sixth sense was aroused when the ear-drum was stimulated by some mysterious substance in the atmosphere like ether or like Von Reichenbach's "od", a hypothetical substance supposed to have been discovered in connection with vital and magnetic phenomena, a force which was assumed to stream from the fingers of peculiarly sensitive persons and from certain metals. Soon a heated debate arose, sometimes called "the battle of the German scientists," which was carried on for years in the German periodicals and at the German conventions for instructors of the blind. The chief protagonists were: L. Truschel, who attempted an acoustic explanation supported by a much keener analysis of the auditory sensations reported by subjects who possess the obstacle sense; A. Krogius, whose elaborate experiments with heated cylinders convinced him that fine discrimination of differences in temperature was a decisive factor in facial vision; and M. Kunz, whose "more than twenty thousand careful tests with eighty persons," carried on through a long series of years with painstaking variations in conditions, made him the chief advocate of the pressure theory. The details of this controversy are too numerous to be reported here, but to the unbiased reader, each seems to have made a contri-

Javal

Battle of
German
Scientists

bution in his own field, leaving the impression already expressed by MacDougall that, considering the probability of individual differences, it is better to assume that the sense of obstacles depends upon the functioning of several senses, rather than to attempt to limit it to one sense to the exclusion of all the others.

Another wave of interest in the obstacle sense occurred in the third decade of the present century. We have already noted in Javal and Hauptvogel the tendency to explain the abilities of the blind by assuming that they have some mysterious power not given to ordinary mortals. The lure of the unknown is always appealing, and when one is disappointed or fatigued with the slow, careful march of scientific investigation, it is relatively easy to cut the Gordian knot by assuming some new force to which we can attribute any specific powers we happen to need. At the beginning of the century, it was the custom to explain various strange phenomena in terms of magnetism, and Mesmer's influence continued long after better explanations were offered for the phenomena he described. In 1874 Scherer had connected the sense of obstacles with the laws of electricity, assuming that objects with like charges repelled, while objects with unlike charges attracted each other. Dr. Felts, in 1909, was so impressed with the marvelous escapes of a blind man on the crowded streets of New York that he concluded the subject must be guided by "a miraculous instinct superimposed by a subconscious mental condition." Gerhardt, in 1920, mentions a blind student who is so sensitive to metals that he is tempted to attribute some magnetic power to his body and suggests further experimentation upon "telesthesia," using a word commonly associated with spiritistic phenomena (a supersensitivity to objects at a distance without stimulation through the ordinary channels of sense). Jules Romains, 1924, espouses "eyeless sight," being convinced that it is possible to read large print through the skin by means of corpuscles which give an image in somewhat the same way as the multiple eyes of insects. At one time we may all have had the power to see through the skin, but recognizing the superiority of the eyes, we have allowed our "skin-seeing" to become atrophied. Under certain conditions of concentration and confidence, Romains thinks our "paroptic" vision may be brought into function again.

After this brief excursion into the occult, it is refreshing to turn to Villey's common-sense treatment of the subject. In 1918 he had criticized Kunz and Krogius for attributing a distance sense to the deaf-blind, since Helen Keller and Eusapia Malossi had both informed him in personal letters that they did not possess the sense of obstacles; and he had repeated Javal's query, "If the impressions we are now considering are really exclusively sensations of pressure, is it not strange that no blind person has yet been found capable of perceiving an object in front of his hand or near his lips?"—two of our most sensitive areas. He concludes that the obstacle sense is largely a function of the ears, but he follows MacDougall rather than Truschel. Sounds are constantly rolling in upon us from all directions, but when an obstacle is between us and any source of sound, this obstacle will deprive us of so much auditory sensation, and we explain this deprivation by inferring the presence of the obstacle. He suggests that the tendency of the blind to localize this perception in the forehead may be explained as an auditory illusion, similar to the localization of a sound inside the head when a single stimulus is conducted to the two ears simultaneously by means of a forked rubber tube. After making a study of the obstacle sense among soldiers blinded in the World War, Villey, in 1923, concludes:

> I am persuaded that the auditory element occupies a very important place in the majority of cases, even among those who have little or no consciousness of it. But the tactile element is certainly not negligible and may sometimes be preponderant. These two factors seem to have essential roles according to the differences of individuals: there are perhaps tactiles and audiles from the point of view of the sense of obstacles. But it may be that the perception of obstacles attains its maximum intensity only when the two orders of sensation are combined.

Bürklen, 1924, summarizes the factual discoveries to date as follows: the distance sense is favored by attention, large objects, slow approach, warmth, dryness, darkness, and, according to Kunz, by hypersensitiveness of the skin after sickness. Unfavorable factors are the arousal of another sense which may cause distraction, cold, dampness, and covering of the face, especially the forehead. The influence of electricity or of rays of various sorts is not known, nor have we experimental evidence of the effects of practice.

Lamarque

The latest contributions to the problem come from Georges Lamarque and Wladimir Dolanski. Although written in 1910, Lamarque's *Le perception exterieure chez les aveugles* was not generally known till 1929, when Villey published certain sections of his work under the title, *La Sensation des Obstacles chez les Aveugles.* Dolanski's work appeared in 1931. Both authors prefaced their own work by a careful review of that of their predecessors, and both made real scientific contributions, though Lamarque's work was only begun when he was called away to the defense of his country and lost his life. Lamarque called attention to the "fallacy of the single case" in experiments upon the blind. Within his own small group of subjects, he found wide variations of ability and sensory preference and suggested that the contradictory results reported by the German experimenters might be explained by the preponderance of one or another type of subject in the different groups studied. Generalizing from selected cases is, of course, a dangerous procedure when seeking comprehensive truths. And Lamarque pointed the way to the development of improved techniques. Instead of seeking to determine the nature of facial vision through the elimination of one sense avenue after another, thus producing an unnatural and artificial condition in the subject, why not begin at the physical end and study the sensory stimuli which were assumed to produce facial perception? So Lamarque describes an apparatus capable of measuring pressures down to one tenth of a milligram with which sponsors of the pressure theory may determine the amount of pressure produced by currents of air and decide whether such faint stimuli could reasonably be expected to have a perceptible effect upon the skin. For the advocates of

Measure
air pressure

the auditory theory, he describes the mechanical recording of sound waves from a tuning-fork and a music-box (a) in isolation, (b) with screens of various materials placed behind the sound-producing instrument, and (c) between the producing instrument and the recorder. Examination of the curves when greatly enlarged showed the objective existence of certain modifications in the sounds, which might be assumed to form the basis for conscious differences in the perception of these sounds.

Measure sound productions

Dolanski stands upon the shoulders of his predecessors in the best sense of that phrase. After a careful study of the work done before him, he describes a well-planned series of experiments, carried out under scientific controls, and presents a new theory of the obstacle sense which will challenge the thoughtful consideration of specialists. In order to establish standard conditions and to eliminate all factors except those involved in the approach of an object, he constructed an apparatus which would carry toward the individual experimented upon, discs of various sizes, without noise, and at a rate of speed so slow that there could be no possibility of the production of currents of air. In his series of experiments, the subject sat: I, with the face uncovered; II, wearing a sort of helmet made of thick paper, having flaps at the sides which cut off sounds coming from the front but did not cover either the face or the ears; III, wearing a cardboard mask the shape of the face; and IV, with ears plugged with cotton. All subjects having any vision were fitted with black glasses set close to the head. Each session lasted about forty-five minutes, and ten trials were made with each of the discs which ranged in size from 20 to 500 millimeters in diameter.

Dolanski

Procedure

Dolanski used discs of varied materials—sheet-iron, wood, pasteboard, glass, and cloth—but this difference in materials did not seem to have any effect upon the results. Fatigue or distraction, however, greatly reduced the ability to detect the approaching discs. Dolanski concludes that audition is clearly fundamental in arousing the sense of obstacles and not touch or temperature sensations produced by external stimulation of

Conclusion

the skin. In Series II and IV, where hearing was either interfered with or entirely prevented, the largest disc, five hundred millimeters in diameter, collided with the face without being perceived before it touched the skin. In Series I, the discs were detected at distances proportional to their size. The subjects, themselves, were greatly surprised at their inability to detect the obstacles in Series II; but they were equally surprised at their success in Series III, for they were so convinced of the importance of pressure sensations upon the face that they could not imagine locating obstacles when the face was covered by a mask. The fact that they located the discs as well with a mask on as without it seems very strong evidence against the pressure and temperature theories. On the other hand, certain subjects signaled the presence of an obstacle in Series IV, with the ears plugged, when the disc was no where near them, and the apparatus was not even in operation!

As a further check upon the pressure theory, Dolanski made a study of the action of the air when a solid object is moved through it. Giving a physicist's diagram of the whirlpools produced by an advancing object, he showed pretty conclusively that there is no scientific justification for the common assumption of writers upon facial vision that a person pushes a column of air in front of him when he moves, which may be reflected back from objects and stimulate his own face. Apparently this theory is based on a false analogy from our everyday experience of echoes and reflected sounds.

Dolanski's positive contribution is his new theory of the origin and nature of the sense of obstacles. All living beings, he reminds us, have a native desire for activity and free movement, but the blind suffer such repeated injury that desire for activity is in constant conflict with the fear of consequences.

> The constant apprehension of disagreeable surprises for which he knows neither the source, the time, the extent, nor the gravity forms in the mind of the blind man a disposition to expect evil. Hence his attention is always on the alert, directed to minor details to which the seeing attach no importance. The least noise, the lightest murmur, the echo brought by the wind may act as a

check-rein to diminish the force of a shock when the blind man goes walking. At the same time, the face, the temples, and the forehead sense a light brushing, and this occurs whether or not there is a real obstacle present, and whether a real sound is reflected or an illusion has occurred. A slight declivity of the earth or a plank which gives under the feet is sufficient to cause the same cold current down the limbs and over the whole body. The cause of these sensations, which seem very much like touch sensations, is the certainty that one is menaced with an accident.

The sense of obstacles, then, is merely one of the physiological responses to fear, analogous to the "gooseflesh" of human beings and the hair-bristling of animals, and is caused in the same way by the contraction of small muscles under the skin. Sounds give the cue to the presence of danger, and the instinct of preservation arouses the response in the skin, which is then misinterpreted by the blind as the result of external stimulation. When these cues come, the sensations in the face occur, even if the subject is wearing a mask; when sounds cannot get to the ears, no sensations arise in the face, even if one is really in danger from an approaching object of which the subject has no knowledge; when sounds are misinterpreted as indicating the presence of an object, we have the illusory perception of obstacles.

The sense of obstacles has attracted attention from a very early period. It has constantly aroused wonder in the casual observer, and in recent years it has piqued the curiosity of the scientist. Highly fanciful explanations, often bordering on the occult, have vied for acceptance with the biased theories of amateur experimenters, and both have outshone the modest conclusions of trained scientists. Very few extensive surveys have been conducted with scientific controls. The commoner practice has been to select as subjects those individuals who claimed to have this special ability and then to experiment with them by eliminating one sense avenue after another. Apparently theory has often directed procedure and prejudiced interpretation, for many of those espousing one or another explanation have been unable to view with calmness any data contradictory to their own, and many of the experiments seem to have been planned to confirm a theory rather than to determine the facts regardless of results. We are still uncertain whether the obstacle sense is merely a heightened sensitivity in one or more of our well-known sense organs, the response of some hidden sense organ yet to be discovered, or the interpretation of slight cues obtained from one or several sense organs. It may be, as Dolanski suggests, that the obstacle sense is quite complicated and indirect, the external stimulation, whether coming to us through the ears, the skin, the nose, or the muscles, serving merely to arouse fear which, in turn, causes reflex changes in the skin which are misinterpreted as direct warnings from the objects to the forehead. Further progress on the problem awaits extended research which should include (a) careful observation of the evolution of the sense of obstacles in blind babies and in subjects of all ages blinded by accident; (b) extended laboratory experiments with large groups of unselected blind subjects, matched with seeing subjects of equal ability aside from vision; (c) careful standardization of procedure with provision for control of all variable factors in the subjects and in their environment; and (d) physical measurements of the stimuli assumed to arouse sensory response in the subjects.

The methods of science may seem slow and ponderous, but they offer the only corrective for the popular psychology of conjecture founded on easy generalization from the data of casual observation.

IV

The Memory of Blind Children

The "wonderful memory" of the blind is proverbial. The blind poet of ancient Greece, the Japanese college of blind historians, blind musicians with incredible repertoires, and occasional prodigies who can recite any part of the Bible at will are cited as proof. Even experienced superintendents in schools for the blind have given testimony in support of the belief, though teachers of spelling generally vote on the other side. When the Binet intelligence tests were first used with blind subjects, early investigators assumed that the blind would surpass the seeing, and placed the digits tests in earlier years for the blind. Apparently the "fallacy of the single case" has long prejudiced our opinion of the memory of the blind, so that occasional striking examples of superior memory have led us to believe that superior memory is a characteristic of the blind as a class. S. C. Swift (10) gives us a paragraph which might serve as a corrective.

> A person without sight recognizes a voice he has not heard for many years, and his memory is instantly hailed as marvelous. The seeing person thus recognized fails to realize that his own visual recognition under similar conditions is every whit as wonderful, and that a blind man is quite as liable to forget a voice as he himself is to forget a face. Pupils in schools for the blind often cause visitors to stand in open-mouthed astonishment at the ease with which historical events and their dates are recited, musical selections rendered, mathematical problems solved, etc. The visitors forget that they themselves are frequently familiar with the same dates, that every properly trained seeing musician plays from memory and without looking at his instrument, and that in the every-day business of life, they themselves solve problems of much

greater difficulty without the use of pencil and paper. A blind typist is seen operating a machine with speed and accuracy, and his memory is praised and talked about for years thereafter. The witness of this marvelous feat employs a stenographer in his office, but he has forgotten that the touch system was used in her instruction and that the keys of the machine are never looked at.

Relatively little experimental work has been done directly upon the memory of the blind, but a beginning has been made, and such memory tests as occur in the Binet intelligence scale have been used with large numbers of blind children. The results seem to indicate that some blind children have wonderful memories and some have wretched memories; that blind children as a whole vary widely in this as in other traits; and that when their memories have not been specifically trained or stimulated, their scores take the form of the normal bell-shaped distribution curve, the large majority having memory ability about equal to the average of the seeing, with fewer and fewer cases as we approach either extreme. We certainly cannot assume that blindness will cause an improvement of memory, through some mysterious process of compensation. Some of us, blind as well as seeing, are gifted with unusual retentive ability, but most of us acquire a dependable memory by an industrious use of all the hints and helps we can marshal to our aid.

TESTS OF MEMORY

Garrett and Schneck (4) write:

> The phenomena of memory may be classified under the heads of fixation, retention, recall and recognition. Fixation, or the ability to get new impressions quickly and accurately, is measured by tests of immediate memory. Retention, or retentivity, is measured by tests of recall and recognition, which may be given at varying time intervals after the original presentation of the memory material. Tests of memory, themselves, may be classified as tests of "rote" memory, or memory for disconnected impressions; and tests of "logical" memory, or memory for connected meaningful material. In rote memory tests the subject is required to

reproduce the material exactly as it is presented, i.e., he must learn it "by heart." In logical memory tests the ideas or meanings involved are asked for, rather than an exact reproduction of the material as presented.

We are following the headings used by these authors in our presentation of the results of tests of the memory of blind children.

A. Rote Memory

1. Simple Immediate Memory

The memory span method is commonly used to test immediate rote memory, the memory span being the longest series of items, whether letters, digits, or words, which the subject is able to reproduce correctly after a single presentation.

a. Digits test.—The ability to repeat lists of numbers is one of the standard items in intelligence testing, so we have data from large numbers of subjects, both blind and seeing. Terman's (11) work in standardizing the Binet tests on the basis of 1000 cases indicated that there is a fairly regular development of this ability up to about twelve years of age, so that by assigning three, four, five, and six digits to the tests located in years III, IV, VII and X respectively, he could expect about the same per cent of passing as the difficulty of the test and the years increase. His numerical results are presented in Table I. Terman placed the seven digits test in year XIV and the eight digits test in year XVIII (superior adult), though his data for these years were scanty and he realized that after the early teens memory for meaningless material improves very little and that ability in this function does not correlate closely with intelligence. Confirmation of Terman's results for children in school comes from an article published by Calhoun (3) on the basis of results obtained by including digits tests in his series of group tests used with 946 subjects "distributed quite evenly through the third to the twelfth grades inclusively, of seven different schools in six counties in central Ohio." Calhoun found that the ability to remember a series of digits long enough to write them down increases quite regularly from the eighth to the fourteenth year and shows little improvement after that age. At the adult level we have several measurements of large numbers of college students which indicate that one may expect them to repeat seven or eight digits, though some writers question the use of eight digits as an intelligence test, regardless of age. "Practice and training," according to Garrett and Schneck, "plays a large role in memory span in the older groups. As a measure of attentive observation and concentration, memory span is of value with young children; but its low correlation with verbal tests of general ability suggests that the digit span has been much over-emphasized in the upper levels of the Stanford-Binet."

Table I gives us the data for an interesting comparison of the blind with the seeing. It is, in fact, the first published comparison involving large numbers of blind subjects. This table is to be read as follows: the three digits test was given by Terman to ten three-year-olds, 70 per cent of whom passed the test, which he located in year III, as indicated by the line under 3. The same test was given to seventeen four-year-olds, of whom 87 per cent passed. The four digits test was given to ten three-year-olds, to seventeen four-year-olds and to fifty-four five-year-olds; and the test was passed by 40 per cent of the three-year-olds who were one year younger than the age at which the test is located, by 76 per cent of the four-year-olds, "at age," and by 83 per cent of the five-year-olds, who were one year older than the age at which the test is located.

First comparing the per cents at age, we note that with the seeing all the per cents for tests with 3-6 digits are in the seventies, indicating that with increase in years, the seeing are about equally successful with progressively longer series of digits; also in each year group the younger children have a lower per cent of passing than those at age, while the children one year above age show per cents in the eighties, consistently higher than those at age. With the blind we find a decidedly different trend, from relatively higher per cents with three and four digits, similar attainment with five digits, and slightly lower attainment with six digits. When more digits are given we find smaller per cents passing both among the seeing and among the blind. There is no significant difference between the two groups when seven digits are given and no conspicuous change from year to year among the blind. The average adult is expected to repeat seven digits and both our groups have reached this level. With eight digits the per cent passing in both groups naturally falls since this is a superior adult test; but the blind do distinctly better than the seeing, in our tables.

Explanations are somewhat hazardous without further experimentation with introspective evidence from the blind on their methods of responding to this test; it would seem obvious that the young blind learn the trick of retaining short series of digits more readily than do the seeing, but that they cannot, or do not, make the changes in method needed for the retention of longer series. One is tempted to appeal to imagery for an explanation. Possibly with short series of 3-5 digits it does not make very much difference whether one uses auditory or visual imagery; in this case the blind would be at no disadvantage and their habits of attention to auditory stimuli might explain their superiority. With larger numbers of digits visual imagery might be progressively more to the advantage of the seeing, and we know that, with the seeing, longer series can be retained when presented visually than auditorially. In general we must conclude that this test of retention shows no superiority for the blind—no memory compensation—but rather an inferiority from about the tenth year onward, and that the occasional blind adolescents who pass digits tests in year groups well beyond the years in which any other tests are passed, even succeeding occasionally with a series of nine digits, are exceptional cases, perhaps endowed with a high degree of that native retentiveness which appears in such a conspicuous form in mathematical prodigies.

b. Reversed digits test.—While related to the simple digits test in material used and in the employment of the memory span method, the repetition of digits in reverse order appears to make demand upon somewhat higher functions than the

TABLE I. PERCENT PASSING THE DIGITS TESTS, AT AGE, AND AT YOUNGER AND OLDER AGES

	Three Digits		*Four Digits*			*Five Digits*			*Six Digits*			*Seven Digits*			*Eight Digits*		
Terman: Seeing Subjects																	
Ages	3	4	3	4	5	6	7	8	9	10	11		High School pupils			16–21	
Number of cases	10	17	10	17	54	117	92	100	113	87	79		32			32	
% younger			40			59			56								
% at age	70			76			74			71			60			37	
% older		87			83			83			80						
Hayes: Blind Subjects																	
Ages	3	4	3	4	5	6	7	8	9	10	11	13	14	15	17	18	over 18
Numbers of cases	11	10	7	18	46	82	131	166	130	132	160	205	180	161	126	118	305
% younger			100			64			66			60			52		
% at age	81			99			67			63			57			49	
% older		100			86			76			72			60			53

TABLE II. PERCENT PASSING THE REVERSED DIGITS TEST, AT AGE, AND AT YOUNGER AND OLDER AGES

	Three Digits			*Four Digits*			*Five Digits*			*Six Digits*			*Seven Digits*		
Terman: Seeing Subjects															
Ages	6	7	8	8	9	10	11	12	13		High school pupils			16–21	
Numbers of cases	117	92	100	100	113	87	79	83	98		32			32	
% younger	35			44			61								
% at age		60			62			66			56			40	
% older			83			75			71		About ½ of average adults			About ½ of superior adults	
Hayes: Blind Subjects															
Ages	6	7	8	8	9	10	11	12	13	15	16	17	17	18	over 18
Numbers of cases	55	108	143	136	173	171	217	212	243	23	65	51	41	73	80
% younger	23			42			51			39			49		
% at age		47			52			48			58			50	
% older			64			62			57			57			30

direct digits test. This test was first standardized by Terman (11, p. 207).

"It is very much harder," he writes, "to repeat a series of digits backwards than in the direct order. Five digits can be given in the direct order at year VII, and six at year X. Reversing the order places three digits in year VII, four in year IX, five in year XII, and six in 'average adult.' Even intelligent adults sometimes have difficulty in repeating six digits backwards, once in three trials. As a test of intelligence this test is better than that of repeating digits in the direct order. It is less mechanical and makes a much heavier demand on attention. The digits must be so firmly fixated in memory that they can be held there long enough to be told off, one by one, backwards."

Table II gives the results for this test, comparing Terman's results with those of much larger numbers of blind subjects. The table is to be read in the same way as Table I. As in the former table, we find the seeing subjects passing the test about equally well in each age group up to the early teens, but showing less success with six and seven digits in the high school period. With the blind, however, we find a trend which is different from the seeing, in that the younger children are distinctly inferior to the seeing while the blind in the later teens equal or surpass the seeing when tested with six or seven digits. Moreover the trend for the test with reversed digits given to the blind is almost the opposite of that found for digits given directly: in this test the blind are poorest in the early years and improve as the years go on; in the test with digits reproduced in the same order in which they are given, the blind are best in the early years and are less successful as the years go on. Terman (11, p. 209) was inclined to explain success in the reversed digits test "by the ability to translate the auditory impression into visual imagery, so that the remembered numbers could be read off as from a book," and noted that children were more likely to succeed if they took time to think through the series two or three times in the direct order before attempting the reverse order. But since many of the blind are unable to depend upon visual imagery, and yet as a group succeed better than the seeing in handling the larger series, even reversing eight digits as demanded in Mr. Irwin's early revision of the Binet tests and frequently repeating as many in reverse as in the direct order, we must assume that they have made some intelligent substitution for visual imagery.

On the basis of the facts at our disposal we must conclude that blind children are superior to the seeing in repeating either short or very long series of digits in direct order, and long series of digits in reverse order; they are inferior to the seeing in repeating series of six digits in direct order and short series of digits in reverse order.

c. Immediate memory for disconnected words.—When psychological testing was begun in the eastern schools for the blind, nearly twenty years ago, group tests of rote memory were among the first to be tried. Preliminary testing with the Pyle (9) rote memory test (in which lists of short, unrelated, concrete and abstract words were read to a grade, with pauses after each list to give time for the pupils to write the words), showed the blind of three schools inferior to the seeing, whether compared by grade, chronological or mental age, but the test was criticized on the ground that many of the words used were probably less familiar to the blind than to the seeing and so more difficult to remember. In 1919-20 about 450 pupils in from eight to ten schools for the blind were subjected to a large number of group tests and the results published in 1921 by the writer (6). Two of the tests used were memory tests, from Pressey's Group Point Scale (8). His rote memory test was given as follows: After the pupils had written their names, age, grade and the date at the top of their record sheet, the tester said, "Now I want to see how well you can remember words that I read to you. Please listen carefully as I shall read the words only once. Do not write while I am reading; wait till I am through and then write what I tell you to write. You may write across your lines till I tell you to start a new line. The first list of words is—Cat, BABY, cow. What word came after baby?" After another sample the test was begun with a list of four words. Three lists of four words were given, five lists of five, six, and seven words, three lists of eight words, one list of nine words and one list of ten words.

This is one of the very few group tests in which blind children get higher scores than the seeing. As arranged by Pressey, the test began with a list of three words and ended with a list of seven; but preliminary tests in two large schools for the blind gave so many perfect or nearly perfect scores that we felt the test was too easy for the best pupils, so Pressey's two-word lists were omitted, and his three-word lists used as examples, which were not counted in the score. At the end of the series new lists of eight, nine, and ten words were added, and throughout the lists certain words were stricken out which seemed unlikely to enter the experience of blind children. When a Supplement (7) was printed in 1925, the results obtained from 615 children from ten years of age upward in two schools for the blind were reported. The curve for the blind was well above the curve for the seeing in every age group, but the greatest superiority of the blind appeared in the early years. From these results it would seem that at ten years of age blind children have mastered much better than the seeing, the ability to hold in mind a series of discrete auditory stimuli (perhaps because they get so much more of their education in and out of school through the use of their ears); and that on the average only a slight improvement is to be expected in the years after. Ten-year-olds are likely to get a score of 10, and at eighteen years the average score is only 12. But we find individuals at ten years with a score of 12, at eleven with a score of 16, and scores up to 19 at seventeen and eighteen. Possibly this test measures a memory ability which does not ordinarily increase very much after the early teens, as was noted in the direct digits test. We have no records of this ability for the years below ten, as children in the earlier grades are not familiar enough with the writing of braille to justify the use of such group tests.

2. *Recall Memory*

Two common ways of testing recall are the method of retained members and the method of paired associates. In the former more items are presented than can possibly be reproduced by the subject, and the measure of memory is the number of these items which a subject is able to recall. Various kinds of materials may be employed in recall memory tests: words, nonsense syllables, poetry, proverbs, pictures, geometrical figures and actual objects. In the method of paired associates, lists of paired terms are presented, e.g. man-sky, desk-stone, etc. When the whole list has been given, the subject is asked to respond with the second word when the first word of a pair is given. Not only words, but nonsense syllables, digits or pictures may be used as memory material; or a word may be paired against a nonsense syllable, or a picture against a number.

Apparently only four attempts have been made to apply these methods to blind subjects. In 1905 an early investigator tried the method of retained members with twenty blind pupils from ten to nineteen years of age, using as material, nonsense syllables, words and poems. But his subjects were too few to give conclusive results. Bond and Dearborn (2) in 1917 compared a class of nineteen boys at Perkins Institution with twenty seeing boys of about the same age, using four lists of letters and three lists of digits chosen at random. The lists varied from twelve to fifteen items. Each list was read once, and the boys reproduced as many items as they could within thirty seconds, the seeing boys writing on paper while the blind boys used braille writers or typewriters. Neither group showed clear superiority. The seeing boys reproduced a higher percent of the items in four of the seven tests, but the authors think they showed more practice effect as their chief superiority was in the final two tests. Vértes (12) in 1919 published results obtained by the method of paired associates, using meaningful material with twenty pupils from seven to fourteen years of age in the schools for the blind at Budapest, and compared his results with those obtained by testing two hundred seeing children in the same way. Vértes also recorded the time needed for each response, using a Jaquet chronometer reading to fifths of a second. He found the blind distinctly superior to the seeing in the per cent of responses correctly given, and in the speed of reproduction, and this superiority was shown when the blind and the seeing were compared as a whole, by age groups, by intelligence or by social status. The author notes that the blind attain their maximum ability at an earlier age than the seeing. Table III gives his results in simplified form.

TABLE III. PERCENT OF CORRECT REPRODUCTIONS
REPORTED BY VÉRTES

			Chronological Age		
Ages	6–7	8–9	10–11	12–13	All
20 Blind....	79.4%	92.3%	89.7%	89.7%	89.7%
200 Seeing..	79.4	83.1	86.4	89.7	82.9
		Intelligence		*Social Status*	
Ages	Good	Average	Inferior	Poor	Well-to-do
20 Blind....	92.3%	89.7%	89.7%	89.7%	89.7%
200 Seeing..	87.1	82.7	76.9	89.4	84.6

The third measurement of the recall memory of the blind comes from Bechtold (1) who in 1925 used the method of paired associates with fifty blind children and fifty seeing children. He used three lists of meaningful words, each containing eighteen pairs of words and three lists of nonsense syllables, each containing nine pairs of syllables. Each list was read through twice, after which the pupils wrote the second word or syllable of each pair when the first was given. With meaningful material the seeing children were definitely superior, but with nonsense syllables the blind did much better than the seeing. The author reports similar results when the same experiment was performed by a colleague with fifty-five pupils in the school for the blind at Chemnitz. He suggests that with meaningful material the seeing perhaps have an advantage because they can retain words as visual images; but that when nonsense material is used the seeing lose this advantage and the blind have a chance to excel because of their better habits of attention to auditory stimuli.

B. Logical Memory

1. Memory for Related Words in General

The ability to remember words or the ideas they express is needed in order to pass most of the tests in the Binet series. An aged person who could not retain impressions long enough to act upon them would make a very poor showing, as would a foreigner of any age who heard but did not understand what the words meant. In some of the tests nothing more is demanded than the ability to recall certain facts already learned, as in the tests for three-year-olds, in which the child is asked to point to parts of the body, to name familiar objects, to give its sex and last name; somewhat more specialized learning is involved in the ability to count pennies, name the days of the week, or the months of the year, name six coins, or count backward from twenty to one. In all of these tests blind children seem to succeed just about as well as the seeing, so these tests have been located in the same age groups.

In other tests of the Binet series, new verbal material is presented to the child, outlining a more or less complicated situation which the child must construct before responding by word or deed. If any of the essential details slip from his memory, he will make a wrong response. Examples of such tests are the Three Commissions, in which the child is given three simple things to do which he must remember and execute in their proper order; the Comprehension tests, in which a situation is created as in the question "What's the thing to do if it is raining when you are out playing?"; Problematic Situations, as in the question, "A little boy is coming into his home crying, and holding an empty bag with a hole in it. What has happened?"; and Absurdities, as in the following, "I know a road from my house to the city which is down hill all the way to the city and down hill all the way back home. What is foolish about that?" Blind children succeed as well as the seeing in the Three Commissions and in the simpler forms of the Comprehension test. Their greater difficulty with the others does not indicate so much that they forget, as that they do not understand the situations as well as do the seeing.

2. *Memory for Words in Sentences*

Specific measurement of the ability to retain and reproduce a series of related words is attempted in the tests called Repeating Sentences, which appear in five different age groups. These would be classed as tests of logical memory to distinguish them from the rote memory tests with disconnected words. Terman's results show a fairly regular development of this ability from three to ten years, and the blind appear to test about with the seeing at the only age level for which we have a fair number of blind children tested, at six years. Here the tester says, "Now listen. I am going to say something and after I am through I want you to say it over just as I do. Understand? Listen carefully and be sure to say exactly what I say." The child is credited with passing if he repeats one of three sentences like the following without error, or two sentences with not more than one error in each. The first sentence is "We are having a fine time. We found a little mouse in a trap." These sentences have from sixteen to eighteen syllables. In the tests for three-year-olds, sentences of six to seven syllables are given, and four-year-olds are given sentences of twelve to thirteen syllables. We have records of tests of very few blind children as young as this, but what we have indicates that the blind equal the seeing. The six year test, consisting of sentences of sixteen to eighteen syllables, and the ten year test consisting of twenty to twenty-two syllables (in each of which we have tested more than one hundred cases) are passed by approximately the same number of blind as of seeing children.

3. *Brief Fire Stories as Memory Material*

The Binet fire story is used by Terman to measure the ability of ten-year-olds in reading a simple narrative and reporting eight of the twenty-one "memories" or items covered. The subject is not warned in advance that he will be asked to report what he has read, but as soon as he has finished reading, the selection is put out of sight and the tester says, "Very well done. Now tell me what you read. Begin at the first and tell everything you can remember." Literal reproduction is not expected. The rule is to count all memories whose thought is reproduced with only minor changes in the wording. When this test was first used with the blind, the fire story was printed in braille and New York point and given to the subject to read; but it was found that ability to read by touch varied so widely, irrespective of intelligence, that it was better to read the selection to all children who had not vision enough to read the large, heavy type version of the story printed in the Guide adapted for use with the blind. Possibly the blind are still slightly at a disadvantage in this test since the retention of the details taken in through the ear may be more difficult than when they are read by the eye. We know the memory span for digits seen is higher than for digits heard. But the numerical results are not far apart, 69 per cent of the 87 seeing ten-year-olds, and 60 per cent of the 112 blind ten-year-olds being able to pass the test.

In the logical memory test included in Pressey's Group Point Scale another fire story was used, and retention measured by the number of questions on the text which could be answered correctly. Sample questions are: 1. Were the buildings insured?; 2. Was the oldest child overcome with smoke?; 3. Was she rescued by her father? There were twenty questions in all, some of them being "leading questions," i. e., intended to mislead anyone who did not consider them critically, thus testing the accuracy of the memories retained. In this test the curve of results obtained by testing 654 blind children in ten schools for the blind closely paralleled the curve for the seeing, rising gradually from a score of 9 at ten years to a score of 13 at fifteen years. The curve for the seeing first became higher at the thirteenth year and ended two points higher at the sixteenth year; but in every year from the tenth onward, there were individual blind children who reached the seeing average for the sixteenth year, and as early as the thirteenth year we find blind children who attained the perfect score of 20. One might expect the blind to excel in this test on the ground that they are read to more frequently than are the seeing; but this advantage may be counterbalanced by the fact that the seeing have more chances to visit fires and read newspaper accounts of them, thus having a better basis for associative retention.

4. Stories with Many Ideas

Pyle (9) proposed the use of extended stories to test pupils' facility in remembering and reproducing ideas, and suggested that their standing in this test might be a good indication of their ability to remember the subject matter of the school studies. Two of his tests were used at about the same time, Bond and Dearborn (2) testing with the story of the Golden Goose at Perkins Institution and Hayes testing with the story of the Marble Statue in the schools at Batavia and Philadelphia. Following is the text of the Marble Statue with the sixty-seven ideas indicated by lines of division: A young / man / worked / years / to carve / a white / marble / statue / of a beautiful / girl. / She grew prettier / day by day. / He began to love the statue / so well that / one day / he said to it: / "I would give / everything / in the world / if you would be alive / and be my wife." / Just then / the clock struck / twelve, / and the cold / stone began to grow warm, / the cheeks red, / the hair brown, / the lips to move. / She stepped down, / and he had his wish. / They lived happily / together for years / and three / beautiful / children were born. / One day / he was very tired, / and grew / so angry, / without cause, / that he struck her. / She wept, / kissed / each child, / and her husband, / stepped back / upon the pedestal, / and slowly / grew cold, / pale / and stiff, / closed her eyes, / and when the clock / struck / midnight / she was a statue / of pure / white / marble / as she had been / years before, / and could not hear / the sobs / of her husband / and children. Of course the text must be read smoothly without reference to the division into ideas; the marks serve as a key for scoring. This test was given to 184 blind boys and girls, and when the results were tabulated according to mental age, a very regular upward curve emerged, rising from a median score of 6 at mental age six to a score of 40 at mental age eighteen. The reason for using mental ages was that at this period little progress had been made in eliminating low grade pupils from the schools, so that curves by grades or chronological ages were exceedingly irregular. When compared with Pyle's results from large numbers of seeing children, we find the curve for the blind taking a similar course and standing intermediate between his curves for city and country children. When compared with the city children, the blind seem about three years retarded, Pyle's curve for the years eight to thirteen being practically the same as the curve for the blind for the years eleven to sixteen; but this in turn is paralleled by the curve for country children for the years fourteen to eighteen. We cannot conclude, therefore, that in this test the blind are either superior or inferior to the seeing as a whole, and as Pyle has over five hundred subjects for every year from eight to fourteen, and large numbers for the other years, his results must be representative.

Bond and Dearborn reached a different result in their use of Pyle's story of "The Golden Goose" at Perkins Institution. They compared nineteen high school boys at Perkins with twenty boys of about the same age in the Rindge Technical High School, 234 pupils in grades II to VIII inclusive in the Houghton Grammar School, fourteen students at Harvard and eighteen students at Radcliffe in courses of educational psychology. The story was read once to each group, the seeing subjects writing what they could remember on paper and the blind boys using braille writers or typewriters. Five days later all the subjects were asked to reproduce again as many elements of the story as they could. They had not been told that the test would be repeated. Those who had considered the story since the first writing were asked to indicate this fact on their papers, and papers so designated were not included in the results. The results show a gradual increase in ability through the seeing grades, with some superiority for the Rindge high school students; the college students surpassed the latter, while the blind boys clearly surpassed all the other groups. Their first test showed an average reproduction of 87.7 per cent as contrasted with 69.9 per cent for the Rindge boys; their second test showed a 95.9 per cent retention as compared with 92.4 per cent for the Rindge boys. Dearborn explains this superiority of the blind in terms of training: to succeed in school they must be attentive listeners, and in life they will avoid numerous inconveniences and difficulties only if they remember what is said to them.

Our review of the evidence does not reveal any general compensatory superiority in the memory of blind children. In rote memory, where we have the largest number of cases, we find the blind excelling in the short series of digits forward and the long series of digits reversed. They seem to do better than the seeing with nonsense syllables but not so well with real words. In tests of logical memory, equality rather than superiority, seems to be the verdict. It would appear that where there has been a need for special attention, or a motive for retention, the blind have learned to make better use of their native abilities, but that they succeed no better than seeing children might do if equally interested. In memory, as in sensation, compensation is not a gift but the reward of persistent effort.

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For additional references see Helga Lende's *Books about the Blind*, pp. 85-86.

V

Intelligence and Amount of Vision

TEACHERS employed in schools for the blind soon discover that every grade includes pupils of such varying abilities and conditions that few statements about a grade as a whole are true of all the individuals in the grade. Differences in the cause of blindness and in accompanying physical defects; differences in the age at which vision is lost and in the time at which instruction without the use of the eyes is begun; variations in preschool education for those losing vision in babyhood and variations in speed of adjustment for loss of vision through accident or disease; differences in the amount of vision remaining and the differences in attitudes and behavior consequent upon this—all combine to make a school grade a very complex unit; while a whole school for the blind includes so many types of pupils that, in proportion to its size, it is perhaps one of our most heterogeneous groups of children.

Various attempts have been made to shed light upon the status of the blind school population through special studies of selected groups. The writer earlier has presented the available evidence concerning the effect upon school success of such factors as the cause of blindness, the age at incidence, the age at entrance to a school for the blind, and the sex of the pupils; on the effect of the degree of blindness he could only quote the general impression of teachers, and Pechstein's[1] conclusions from a study of grades in one school, that pupils with no useful vision tend to do better work than those with a little vision, because the possession of a little vision renders the latter unwilling to rely upon touch as the totally blind do, causing dissipation of effort, insufficient practice in the use of the fingers, and generally poor schoolwork. The present article takes up again the question of the possible influence of the amount of vision.

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[1] Pechstein, Louis A. "Factors Influencing the School Success of the Blind." *School and Society,* XIX, 1924, pp. 47-52.

The recent survey of various schools for the blind by the Committee on Statistics of the Blind sponsored by the American Foundation for the Blind and the National Society for the Prevention of Blindness, introducing a standard method of classification for degrees of vision, gives us the data for a new study. The question was precipitated by a letter from a school superintendent who sent in a table of figures which seemed to indicate that, in his school at least, intelligence went down as vision went up; *i.e.,* that pupils with the smallest amount of vision tended to have the highest intelligence quotients, while with an increase of vision, the level of mentality tended to fall. He naturally wanted to know whether this was true of other schools, and, if so, what explanation might be made of the paradox. A circular letter was then sent to a number of schools in which the survey of vision had been completed and the pupils were known to have been recently measured with the Hayes-Binet Intelligence Tests. This article gives the results for 1367 pupils in nine schools for the blind.

For each school a scatter diagram was made showing the distribution of I. Q.'s in each of the following vision groups:

1. Totally blind, or light perception only
2. 2/200 but less than 5/200 vision
3. 5/200 but less than 10/200 vision
4. 10/200 but less than 20/200 vision
5. 20/200 vision

5a. More than 20/200 up to and including 20/70 vision
5b. More than 20/70 vision

The median I. Q. for each vision group was then calculated and curves plotted to show the trends of intelligence through the vision groups in each school. The median for each school as a whole was also calculated. Table I, below, gives the results.

TABLE I. MEDIAN I. Q.'S BY SCHOOLS AND VISION GROUPS

No. of school	Whole school	Vision groups Group 1	Group 2	Group 3	Group 4	Group 5	Group 5a	Group 5b
Total No. of Pupils	1367	537	201	207	150	137	113	22
I	100	100	103	92	86.5	100	90	—
II	93	97.5	90	88	88.5	90.5	91	—
III	101	111	103	104	98	90.5	88	79
IV	90.5	93	90	90	86	93	91.5	—
V	97	100	90	95	99	106	97	—
VI	98	104	88	100	98	95	99	92
VII	101	109	88	103.5	98	98.5	83	97.5
VIII	103	109	102.5	106	103.5	95	—	—
IX	94	102	100	84	94	96	91	—

When these figures are plotted in curves, a fairly clear downward trend appears in the median I. Q.'s in succeeding vision groups, though there is an upward swing in the later groups in some of the schools. In all the schools the first group, totally blind, stands above the median for the school as a whole, except in School I where the median is the same; vision group 1 also stands above groups 2, 3, and 4 in practically every school, the exceptions being that vision group 2 is higher in School I and group 5 is higher in School V; vision group 1 stands above groups 5 and 5a in seven schools and above group 5b in the three schools reporting I. Q.'s for more than one case in group 5b. Group 1, then, with the least vision, tests highest in intelligence, and although the curves are irregular, the trend is downward for intelligence as the degree of vision increases.

Considering the similarity of the curves, it seemed justifiable to combine the results from all the schools, thus giving more significant numbers of cases for each vision group. The data for all the boys and girls were first assembled separately in two scatter diagrams and then combined. Table II gives the results in numerical form.

TABLE II. MEDIAN I. Q.'S BY VISION GROUPS, ALL SCHOOLS COMBINED

	All vision groups	Vision groups 1	2	3	4	5	5a	5b
Boys and Girls Combined	96	100	95	95	92	94	90	93.5
Boys	97	102	97	93.5	95	94.5	90	94
Girls	95	99	93	96	89	94	91	93

It will be observed from this table, that the median I. Q. for vision group 1 is higher than in any other group when the boys in all the schools are considered together, when the girls are considered together, and when the boys and girls are combined; and that there is a general downward trend in the I. Q.'s as one moves into the groups having more vision. It will also be observed that the figures for the boys and the girls are quite similar. The range of I. Q.'s for the two sexes is also quite similar, the highest I. Q. among the 734 boys being 164 and the lowest being 45; while for the 633 girls we find the highest at 158 and the lowest at 42. This corresponds with the former comparisons of blind boys and girls in the results both of achievement and of intelligence tests, and justifies us in combining our data in a single diagram. It will be noted that there are 101 more boys than girls involved.

This scatter diagram has been prepared for several reasons. It presents in readily accessible form the data for 1367 pupils, with which the results from any other school can be easily compared. It shows the distribution of I. Q.'s for each vision group and the curve formed by their medians. It makes evident the great differences in the vision groups, not only in numbers involved, but in the range of scores and their location with reference to the medians. Teachers of experience with the blind would perhaps expect to find most of the very high I. Q.'s in the low vision groups, as is the case; but it may be a surprise to discover that this group also contains a considerable number of low I. Q.'s—thirty-five below I. Q. 70. In comparison to the size of the group, however, this number is not out of proportion, the 6.5 per cent for group 1 lying midway between the 4.5 per cent for group 5b and the 10.5 per cent for group 2.

Some readers will be surprised to find so many pupils (135 or nearly 10 per cent of the total) in groups 5a and 5b, where the amount of vision, more than 20/200, would seem to make them suitable candidates for sight-conservation classes. Others will be disturbed to see that in spite of the use of intelligence tests, there are still fifty-three boys and fifty-one girls with intelligence quotients below 70, the conventional limit below which pupils are, at least tentatively, classed as feeble-minded.

The main contribution of the scatter diagram is its definite answer to the question raised in this paper, Does intelligence go down as vision goes up? The curve of medians makes it very plain that, so far as we may take I. Q.'s obtained by our adaptations of the Binet tests as indications of intelligence, this question must be answered in the affirmative, paradoxical as the statement may sound.

A further study using group *means* tells the same story, and even more definitely, as may be seen from Table III. There is a distinct drop from Group 1 to Group 2, and then a smaller but still consistent decline through Group 5a. Again Group 1 is distinctly above the mean for all groups combined, as was noted in our discussion of Tables I and II based on a study of medians.

TABLE III. MEANS AND STANDARD DEVIATIONS OF I. Q.'S OF THE VARIOUS VISION GROUPS

	All groups combined	Groups by amount of vision						
		1	2	3	4	5	5a	5b
Mean	96	99.7	94.9	93.9	93.4	93.3	90.6	95.2
S.D.	18.06	19.13	18.76	16.67	15.52	16.65	15.33	14.12

Variance analysis of this material demonstrates conclusively that the decline in means from group to group is greater than could possibly be attributed to chance factors alone. Such a variation in group means would arise through the operation of chance factors alone so rarely (less than once in ten thousand times) that this possibility can be disregarded, and the decline can be confidently ascribed to the known difference between the groups in their amounts of vision.

Another method of measuring relationship of amount of vision and I. Q. is to calculate the Pearson (product-moment) coefficient of correlation between them. In this case there is a small negative correlation, expressed by a coefficient of —.14. While this is small in absolute size, indicating a relationship that is not very close, it is five times as large as its standard error (±.027), and is highly indicative that some measure of relationship exists between these two characteristics. A correlation as marked as this would occur by chance less than once in ten million times, where groups as large as these are concerned. (This is an even smaller probability of chance occurrence than that obtained by the method of variance analysis. It is smaller because a correlation coefficient takes into account the *consistency* of the decline in the means, while variance analysis measures only the unlikelihood of the observed variation among group means.)

No explanation of our paradox seems to emerge from a study of the figures, but must be sought through a consideration of the principles and practices which determine the admission, retention, and discharge of pupils in schools for the blind. The differences in the curves for the different schools suggest that a variety of factors may be at work, and raise the question whether the adoption of a common policy might not be an advantage.

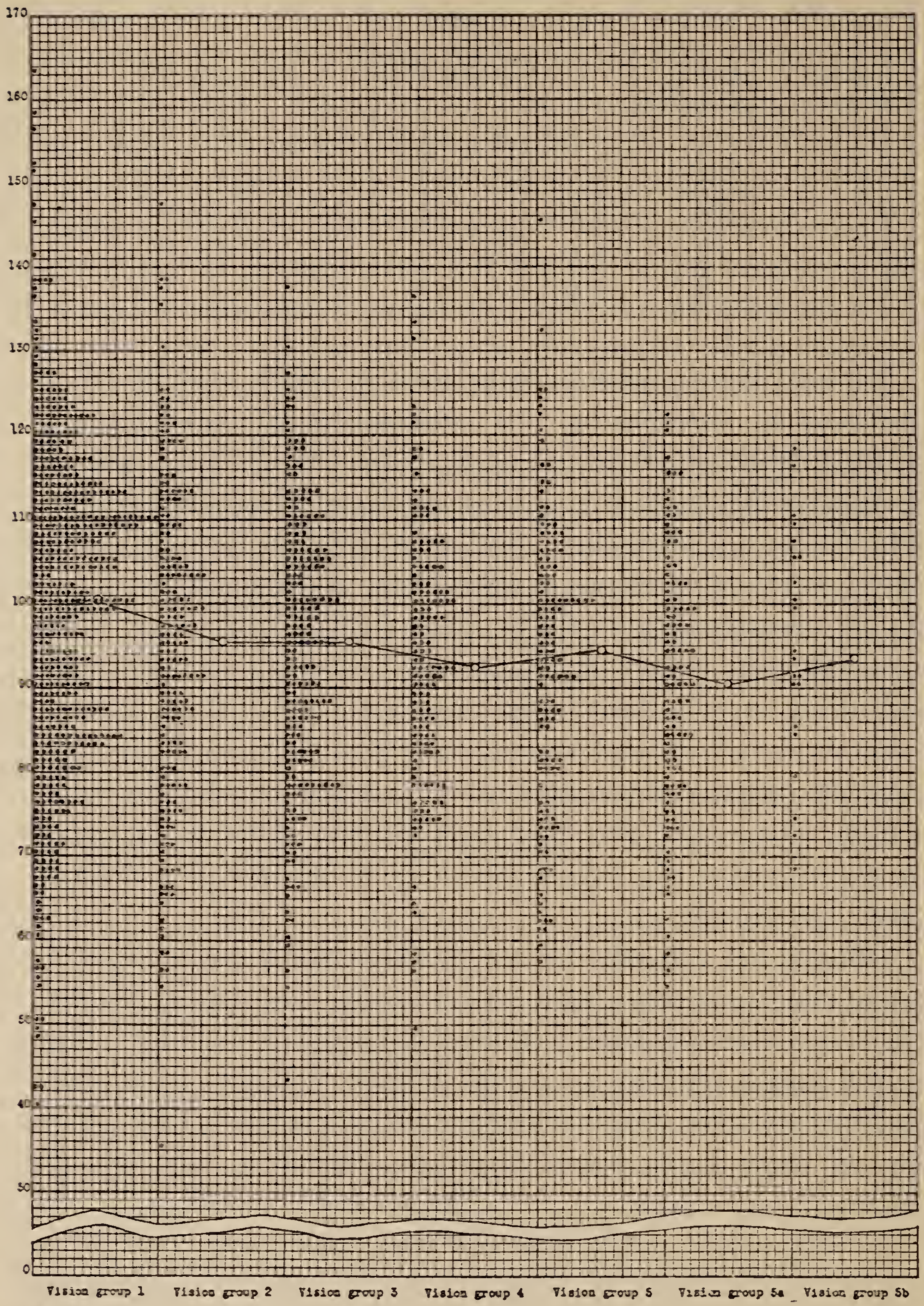
Table IV may give some hint of the factors involved. Obviously there are marked differences in the make-up of the various schools, and it would seem more reasonable to assume that these differences reflect different policies of selection, retention, and discharge than that such marked variations exist in the blind populations of the nine states involved. Of course differences in the examination records made by different oculists may be another factor. It is certainly surprising to find the proportion of totally blind pupils (Group 1) varying from 53.5 per cent down to 19 per cent, while in Group 5, where pupils have 20/200 vision, the proportion runs from 1 per cent up to 28.5 per cent. It is still more surprising to find such considerable numbers in Groups 5a and 5b, when we remember that the National Society for the Prevention of Blindness recommends that children having from 20/200 to 20/70 vision (Group 5a) should be in sight-saving classes, except in special cases, and that those with more than 20/70 vision (Group 5b) should be in the regular public school classes.

TABLE IV. RELATIVE SIZES OF THE DIFFERENT VISION GROUPS

Number of school	Total no. of pupils	Approximate per cent in each vision group						
		1	2	3	4	5	5a	5b
I..........	105	53.5%	24%	12%	5.5%	1%	4%	—
II..........	141	51	13	15.5	10	4	5.5	1
III..........	207	33	23	10	8	12.5	10.5	3
IV..........	270	41	20	17	12.5	5	4.5	—
V..........	299	43.5	6	27.5	13	4	6	—
VI..........	147	24	11	7.5	8	28.5	16	5
VII..........	93	36.5	5.5	3	12	20.5	16	6.5
VIII..........	42	19	28.5	12	9.5	24	5	2
IX..........	63	36.5	11	8	21	11	12.5	—

Several factors have been suggested which may be of importance in determining the relationship of intelligence to amount of vision. It would seem likely that children who are conspicuously blind would be more likely to seek admission to schools for the blind than children with some vision; but after being tested or tried out in the grades, those at the lower end of the mental scale might be more readily discharged as uneducable than pupils of similar low mentality who had some useful vision. The latter might be retained for their practical value in the school and because they give promise of becoming valuable citizens when trained in manual occupations at the school. We notice that there are twice as many boys as girls in vision group 5b, which seems to fit in with this "handyman" hypothesis.

Outside the schools for the blind, another process may be going on, at the same time, which would also tend to increase the proportions of those with low intelligence and high vision. In the public schools, a certain number of children are doing poor work, and a study of the situation may show that a number of them have defective vision. Probably they are also defective in intelligence; for a bright child can often succeed with very poor eyes. But the defective vision might readily be assumed to be the cause of the poor schoolwork, and the children sent to schools which specialize in methods of teaching those with poor vision, thus causing another increase in the high-vision low-intelligence group. On the other hand, some schools for the blind receive a certain number of high-vision pupils of good intelligence, those who have been in sight-



Median I.Q.	100	95	95	92	94	90	93.5
Mean I.Q.	99.7	94.9	93.9	93.4	93.3	90.6	95.2

SCATTER DIAGRAM OF I. Q. BY VISION GROUPS
(EACH DOT INDICATES ONE I. Q.)

saving classes through the grades and have to turn to a school for the blind for their high school course. Another factor produces a contrary effect. Since it is easier to place pupils who have a little vision, and a school would naturally recommend a bright pupil in preference to a dull one, the consistent drafting off of the top of the high-vision group would leave a residue overloaded with the less intelligent. There may be other factors operating locally. Each superintendent must work out his own explanation of the figures his school yields. At present there seems to be no doubt that, in the *nine schools* we have studied, there is an inverse relation between vision and mentality; i.e., that intelligence goes down as vision goes up.

VI

Are We Getting Poorer Mental Material in Schools for the Blind?

For a number of years various leaders in the education of the blind have been prophesying that, with the increasingly successful efforts for prevention of blindness, we should see a progressive lowering in the quality of the human material entering residential schools for the blind. Some superintendents look to the future with the greatest misgiving, fearing that ultimately their educational institutions for capable blind children will degenerate into custodial homes for the blind feebleminded, to which they will have to recall the children discharged as uneducable, in order to maintain an enrollment justifying their continuance.

This dark expectation seems to be founded upon two hypotheses, both of which are *theoretically* questionable; and such *facts* as can be discovered are certainly not yet alarming. The first assumption is that the campaign for the prevention of blindness is more likely to be successful in the better classes of homes, so that, as time goes on, there will be relatively fewer average and superior children suffering blindness from preventable causes, while the lower classes of homes will continue to contribute their customary quota. A second assumption, involved with the first, is the belief that intelligence is inherited as a simple unit character in the same way that hair-color and height are popularly supposed to be.

The first assumption can be accepted only after a careful study of the methods used in the prevention campaign, and a consideration of the probable effect upon the production of blindness from different causes. Wherever state laws make obligatory the routine use of silver nitrate, ophthalmia neonatorum should become less and less frequent at all social levels. The success of this movement in reducing blindness due to this cause from 28 per cent of admissions to the schools for the blind in 1906-07 to 8 or 9 per cent in recent years is one of the great triumphs of science over disease, and the small numbers of cases now entering schools for the blind could have little effect upon the intellectual level of a whole school, even if a very large per cent of ophthalmia neonatorum cases were of low mentality. To quote from the Report of the Committee on Conservation of Vision,[1] May 1929:

> In Wisconsin, ophthalmia neonatorum has ceased to be a factor in the causes of blindness. Among school children in classes for the blind or admitted to the state institution for the blind, it was formerly the cause of blindness among more than one-fourth of all enrolled. Today, periods of years elapse without finding a child born in the state whose vision was lost from birth infection of the eyes. Several other states have similar enviable records, while from all schools throughout the country the decline has been directly proportionate to required use of a safe prophylactic immediately after the baby is born.

The decrease in blindness from other infectious diseases should perhaps be attributed rather to the greater care of physicians than to the enlightening of parents, though one might concede that the privileged classes would be more likely to employ physicians who would use routine preventive measures for prospective mothers and would be more expert in treatment of any unhealthy conditions which might develop after birth.

Is it possible that the reduction of blindness from accidental causes may have a lowering effect upon the intelligence level of the schools? Picturing this as a group of normal children, will its reduction leave a larger percentage of children whose blindness is only one component of general inferiority? Accidental blindness has been reduced from more than 16 per cent in the 1920's to about 8 per cent in the 1930's and a recent study of the school population of two large residential schools gave a median level of intelligence for accidental cases about equal to that for the schools as a whole. If accident cases were all superior intellectually, or if larger per cents were involved, one might expect the reduction in these cases to have some lowering effect upon the general level of intelligence. But the admission of 8 per cent "average" children in place of 16 per cent could not conceivably have much influence upon the whole school population.

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[1] Publication No. D63 of the National Society for the Prevention of Blindness.

There is no obvious reason why the prevention campaign should reduce blindness from toxic poisoning, neoplasms, and non-infectious systemic diseases to a greater degree at one level of intelligence than at another, the education of physicians again being the chief hope for these groups; and, in any case, blindness from these causes is very rare among school children. Probably, the teachings of eugenics concerning the marriage of individuals with visual defects assumed to be hereditary would find more fertile soil in the minds of the educated classes, so that relatively less hereditary blindness will come from their ranks, though there are people of every intellectual level who "know the right and approve it, but still the wrong pursue." On the whole we cannot accept as established the claim that prevention will have its chief results in the most intelligent homes, with progressively less effect as one descends the scale of mentality. The highest levels are not immune to birth injuries, infections, and even sporadic cases of feeble-mindedness.

The second assumption, that like breeds like, must be similarly investigated. When feeble-mindedness first began to attract attention in America, certain widely advertised survey studies led people to consider it a highly hereditary trait, and various eugenists carried on a campaign, which sought to preserve our country from the menace of a rapidly increasing production of the unfit, by enacting laws for the segregation and sterilization of undesirables. More careful study has shown that the problem is not so simple. Intelligence, or the lack of it, is not a simple heritable trait, produced by a single determiner in the germ plasm, but varies in finely graduated degrees from the lowest idiocy to the highest reaches of genius, and is now believed to be produced through the action of thousands of "genes" received from the two parents. Innumerable combinations of genes are possible, and predictions are most unscientific.[2] Says Raymond Pearl in *The Biology of Superiority:*[3]

> On the basis of what is now known of genetics, both for human beings and other forms of life, it is to be expected that a wide variety of new and different combinations of genes may occur in virtually every mating of human beings, some of which combinations may be good, some bad, and some indifferent. Certainly modern genetics gives no support to the view that the somatic characteristics of the offspring can be predicted from a knowledge of the somatic characters of the parents. In preaching as they do, that like produces like, and that therefore, superior people will have superior children, and inferior people inferior children, the orthodox eugenists are going contrary to the best established facts of genetical science, and are, in the long run, doing their cause harm.

What then becomes of the assumption that schools for the blind must expect progressively poorer intellectual material? Even granting that in some cases preventive measures may not be brought to the attention of the adults in inferior homes, we cannot be sure that their unfortunate babies will have inferior intelligence along with blindness. And from superior homes there may come enough cases of other kinds to balance the scales.

Fortunately, we need not leave our topic in the realm of theory. In two large schools for the blind, intelligence testing has been carried on continuously since 1916, so that we have records of the mental ability of children entering these schools. These records *do not* show a progressive lowering of intelligence as the years go by. For a study of this material the I. Q.'s obtained by testing the entering students each year were arranged in parallel distributions, and the trend first studied by comparing the median I. Q.'s from year to year. In both schools there were fluctuations up and down, but no general downward movement could be detected. Of course, the proportions of superior and inferior pupils varied from year to year, but both schools have been receiving about as many superior and inferior pupils the last few years as they did in the early years of testing. The tabulations for the two schools are so similar that we feel justified in saving space in this article by combining them in one table, illustrated by a scatter diagram in which each dot represents one pupil; heavy horizontal lines are drawn to facilitate the comparison of the superior, middle, and inferior levels.

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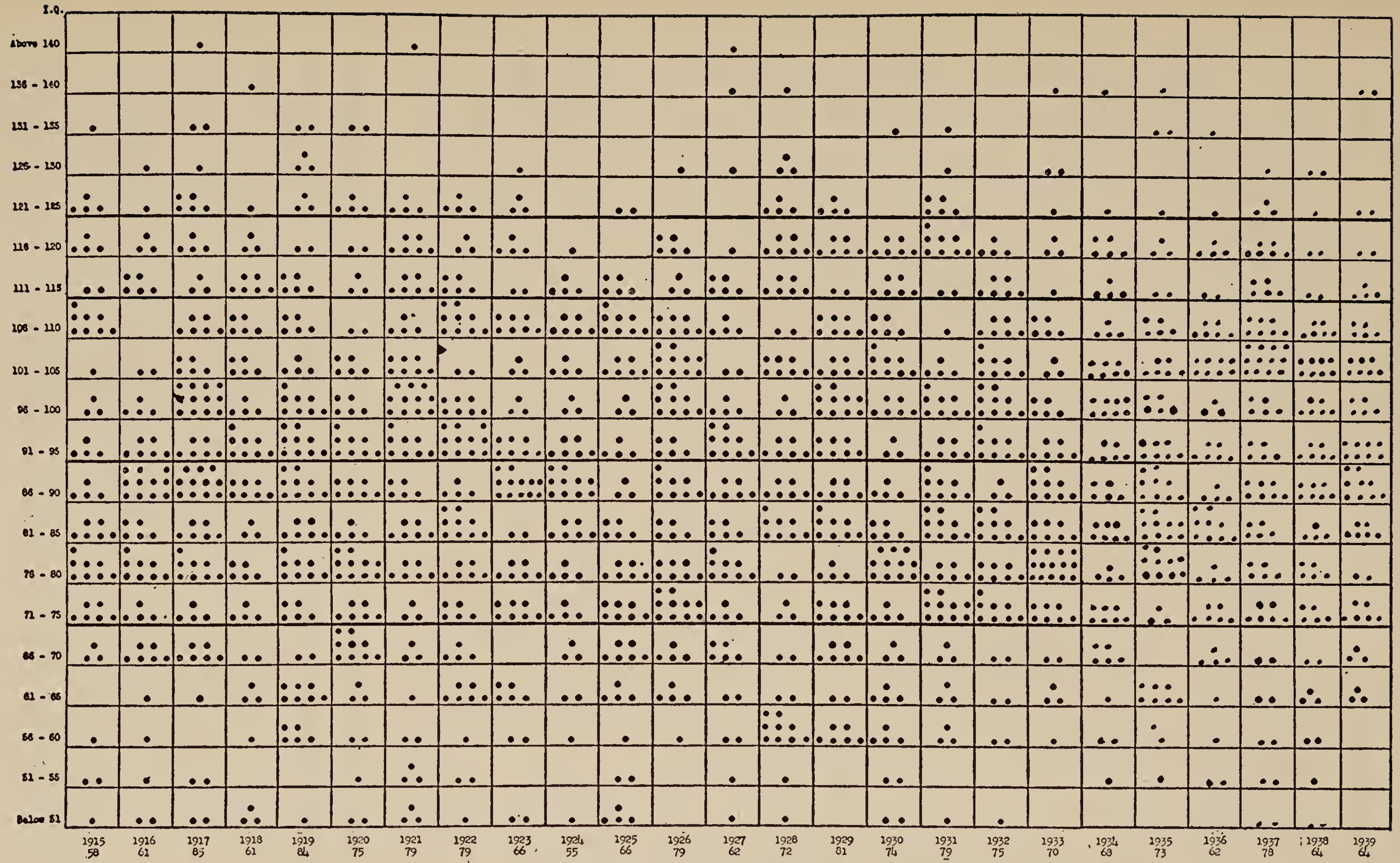
[2] For a review of recent literature see Chapter X, "Changing Concepts of Heredity", in Stanley P. Davis, *Social Control of the Mentally Deficient,* New York, Thos. Y. Crowell, 1930, pp. 389.

[3] *American Mercury* 12:266.

Our table shows that the mean intelligence for every year from 1915-16 to 1939-40 has been a little above 93 I. Q., with the single exception of 1933-34 when it fell just below 91 I. Q. There is apparently *no evidence* that the level of intelligence of children entering these two schools in the last twenty-five years has been falling. If a line were drawn across the scatter diagram at 93 I. Q., it would be perfectly horizontal save for the single dip to 91 I. Q. in 1933-34. The same conclusion follows when we consider the number and proportion of superior, average, and inferior pupils. The number of superior pupils shows great variation, there being nine in 1917-18, eight in 1919-20, and eight in 1928-29 (approximating 10 per cent of the admission in these years), while there were none in 1924-25 or in 1932-33. But when the figures are reduced to percentages of the total number entering each year, we find the curve for the pupils with I. Q.'s above 120 following the same horizontal course as the line of means, each drop being compensated for by a rise. Pupils of average intelligence—with I. Q.'s from 91 to 110—seem to be as common as ever. We find the percentages varying from a low of 19.7 per cent in 1916-17 to a high of 41.3 per cent in 1932-33, but no upward or downward trend as the years go by. The figures for the inferior pupils



Note: The dates indicate the year in which the academic year begins
The figures below give numbers of pupils

YEARLY DISTRIBUTION OF INTELLIGENCE QUOTIENTS OF PUPILS ENTERING
TWO RESIDENTIAL SCHOOLS FOR THE BLIND

range from a high of 25.8 per cent in 1925-26 to a low of 8.6 per cent in 1933-34.

YEARLY DISTRIBUTION OF INTELLIGENCE QUOTIENTS OF PUPILS ENTERING TWO RESIDENTIAL SCHOOLS FOR THE BLIND

				Below 70[a]		71–90		91–110[b]		111–120		Above 120[c]	
Year	N	Mean	S. D.	No.	%	No.	%	No.	%	No.	%	No.	%
1915–16	58	93.39	20.38	7	12.1	24	41.4	16	27.6	6	10.3	5	8.6
1916–17	61	93.08	18.99	11	18.0	28	45.9	12	19.7	8	13.1	2	3.3
1917–18	85	93.49	19.84	11	12.9	29	34.1	29	34.1	7	8.2	9	10.6
1918–19	61	93.38	19.08	9	14.8	19	31.0	22	36.1	9	14.8	2	3.3
1919–20	84	93.34	20.38	15	17.9	28	33.3	26	31.0	7	8.3	8	9.5
1920–21	75	93.15	20.65	17	22.7	27	36.0	20	26.9	5	6.7	6	8.0
1921–22	79	93.47	20.09	12	15.2	20	25.3	30	38.0	12	15.2	5	6.3
1922–23	79	93.27	18.52	14	17.7	24	30.4	29	36.7	8	10.1	4	5.1
1923–24	66	93.21	19.39	9	13.6	27	40.9	20	30.3	6	9.1	4	6.1
1924–25	55	93.12	15.63	7	12.7	24	43.6	19	34.5	5	9.1	0	—
1925–26	66	93.09	21.62	17	25.8	21	31.8	21	31.8	5	7.6	2	3.0
1926–27	79	93.29	16.67	9	11.4	30	38.0	31	39.2	8	10.1	1	1.3
1927–28	62	93.23	19.92	11	17.7	23	37.1	19	30.6	6	9.7	3	4.8
1928–29	72	93.46	21.66	15	20.8	19	26.4	18	25.0	12	16.7	8	11.1
1929–30	81	93.31	18.07	14	17.3	25	30.9	30	37.0	8	9.9	4	4.9
1930–31	74	93.24	20.80	15	20.3	24	32.4	22	29.7	12	16.2	1	1.4
1931–32	79	93.36	1917.	10	12.7	33	41.8	19	24.1	10	12.7	7	8.9
1932–33	75	93.31	16.05	7	9.3	27	36.0	31	41.3	10	13.3	0	—
1933–34	70	90.93	16.73	6	8.6	37	52.9	19	27.1	4	5.7	4	5.7
1934–35	68	93.35	18.05	9	13.2	23	33.8	25	36.9	9	13.2	2	2.9
1935–36	73	93.39	18.30	9	12.3	32	43.8	23	31.5	5	6.9	4	5.5
1936–37	62	93.32	17.86	8	12.9	23	37.1	23	37.1	6	9.7	2	3.2
1937–38	78	93.46	20.11	11	14.1	23	29.5	29	37.2	11	14.1	4	5.1
1938–39	64	93.29	19.14	10	15.6	21	32.8	26	40.6	4	6.3	3	4.7
1939–40	64	93.54	15.51	6	9.3	23	36.0	25	39.1	6	9.3	4	6.3

[a]Inferior group (deficient) [b]Middle group (average) [c]Superior group

A similar study was made of the total populations of these schools year by year, and the figures were treated in the same way. The same results were obtained—the means for the schools as a whole remained practically constant from year to year, and there was no indication of an increase of the inferior or a decrease of the average and superior groups.

Our figures, then, *do not* give support to the assumption that the schools are receiving poorer material or becoming unduly crowded with inferior pupils. Why should anyone hold this view? Several explanations seem possible.

The increasing discussion of the problem of the blind feebleminded and the special difficulties attending the disposal of certain cases might lead one to conclude that the inferior are more numerous, when as a matter of fact they are merely receiving more attention. And if for several years no very brilliant pupils happened to come to a school, the superintendent might conclude that the group as a whole was below average. The illusion of "the good old days" is difficult to escape without a careful periodic study of scientifically kept records. Also it is quite possible that a larger proportion of inferior blind children are now being discovered by our field agents and brought to the schools; of these a larger percentage would of course be rejected as a result of the greater dependence upon preliminary testing, but the impression might arise that the stream of entering material was progressively less intelligent.

Dr. Holloway[4] calls attention to the increase of Slavic and Italian names at the Pennsylvania Institution for the Instruction of the Blind, and records his impression that "as a group their mentality is inferior to that of the other children considered as a group," suggesting the advisability of an investigation from an economic and immigration standpoint, since the same influences would affect the school populations of the New England, Middle Atlantic, and North Central States.

Our figures do not include applicants who are rejected, but only those who stay long enough to be tested and counted in the enrollment of the school. If it were shown that increasingly large numbers have been rejected because of mental deficiency, support might be obtained for the assumptions we have been criticizing; but we should also have to discover whether there were not appreciable numbers of children of the higher levels who are educated at home, or sent to the sight-saving classes in the public schools.

In other words, a final solution must await a complete count of the young blind population, and not just those found in the residential schools. And in these schools we find differences in the proportions of the different I. Q. groups which may reflect the principles of selection in a school quite as well as they indicate the quality of the human material still becoming blind in spite of the prevention campaign.

In summary we may say that, so far as we can discover from the figures at our disposal, or deduce from the operation of the campaign for prevention of blindness, or from a consideration of the laws of heredity involved in the production of subjects with different levels of intelligence, we should not fear a progressive lowering of the mental material submitted to the care of residential schools for the blind. The problem is undoubtedly complicated and needs further study, but the onus of proof would seem to be shifted to the shoulders of those to whom the future looks so threatening.

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[4] "Contribution of Statistics to the Prevention of Blindness," Publication 164, National Society for the Prevention of Blindness, 1934.

PART II

Mental Measurements in Schools for the Blind

VII

The Work of the Department of Psychological Research at the Pennsylvania Institution for the Instruction of the Blind

THE DEPARTMENT OF PSYCHOLOGICAL RESEARCH was established at the Pennsylvania Institution for the Instruction of the Blind at Overbrook in 1916. Work was begun with four distinct, but closely related, aims:

A. To develop and apply methods for testing the mentality of pupils in schools for the blind;

B. To apply the technique of experimental psychology to some of the problems in the psychology of blindness;

C. To adapt to the blind some of the standard tests in school subjects now so widely used with the seeing, and if possible, to suggest improvements in the pedagogy of the blind;

D. To work towards a method of vocational guidance through the use of mental tests of various sorts.

The general plan has been to have an assistant resident at the school to carry out tests planned by the director, who supervises the work by correspondence and monthly visits.

Very considerable progress was made along *three* of the four lines of work outlined above, and publication of results was begun. A report on the reading of the blind was presented to the teachers at Overbrook in September 1917 and this formed the basis for a pamphlet published in the spring of 1918 (5); at the convention of the American Association of Instructors of the Blind at Colorado Springs in the summer of 1918 a report on the results of standard tests in elementary school sub-

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This chapter, originally published in 1920, has been included in this book because of its value as an historical background.

jects was presented (4); a report, "Spelling at Overbrook" was read to the teachers there in September 1918; and a similar report, "Spelling at Perkins Institution" was given in Watertown in April 1919.

A. Investigation of the Mentality of Pupils in Schools for the Blind

There seems to be no doubt that the attempt to determine the grade of intelligence of young people is a thoroughly worthy movement which, if successfully carried out, will greatly facilitate their educational and vocational guidance. In schools for the blind one might be inclined to think that there is less need for such tests than elsewhere, since the teachers and superintendents are able to know their pupils so well before they are graduated or discharged. But the fact is that teachers do not always agree in their estimates of the abilities of pupils, even after they have known them for years. To an outsider it often seems as though they magnify slight improvement and "hope for the best" when there is very little ground for anticipating creditable attainment. Superior ability, on the other hand, is very likely to be overlooked, as the tests show. And in the case of entering pupils, effective tests give valuable evidence as to the advisability of retaining pupils received on probation.

Two general types of *mental tests* are in common use—the Binet-Simon tests of intelligence given individually, and various single tests or series of tests adapted to measure one or more mental functions when used upon groups of individuals. Both types of tests have been extensively used in our work.

1. The Binet-Simon Individual Tests of General Intelligence

In 1904 a law was passed in Paris requiring the segregation of children of low mental ability in special classes. At that date there were no standard methods of measuring mentality and, to meet the need, a psychologist, A. Binet and a physician, Th. Simon, put together a considerable number of simple psychological tests which they had used in research work upon children, tried them out in the schools and arranged them in age groups. These tests were published in 1905, revised by their authors in 1908 and again in 1911 (1), partly to meet difficulties which the authors themselves had found, partly to satisfy the critics in Europe and America who had used the tests extensively upon thousands of children of all sorts. In America Dr. H. H. Goddard, lately of Vineland, New Jersey, was among the first to translate the tests (2) and adapt them to the measurement of normal and defective children; Dr. R. M. Yerkes, of Harvard University, is well known for his rearrangement of the tests in a point scale (13) instead of a year scale; Dr. L. M. Terman (11) of Leland Stanford University, has extended the scale upward, somewhat changed the order of tests and standardized the procedure of giving and scoring. The tests have been used not only upon children in the public schools and in institutions for defectives, but also upon children in reformatories, in juvenile courts, charitable institutions, etc. They have also been widely used upon adults—in reformatories and prisons, in employment bureaus, in institutions for epileptics and the insane, at ports of immigration, and in a modified form in the army and navy. An enormous literature has grown up dealing with the criticism, revision and standardization of the tests, and college courses are now given which are devoted exclusively to the study of the Binet and other tests of mentality.

Mr. R. B. Irwin, then supervisor of the education of the blind in the public schools of Cleveland, Ohio, early recognized the value of such tests for the classification of blind children in the public schools. His contribution to the work is thus explained in a letter to the writer:

> In 1914 I went to Vineland with the idea of working with Dr. Goddard on a study of intelligence tests with a view to the revision of some existing scale so that it might be used more appropriately with the blind. It soon appeared that this was not a task that could be completed in one summer, or one year. Dr. Goddard assisted me in the collection of all sorts of tests, which I arranged in a tentative order with a view to their being tried out on a large number of blind children. The aim was that they should ultimately

> be arranged and published in a form that would be useful to any mental examiner. The Binet measuring scale was taken as a basis. Tests which clearly depended upon vision for their proper performance were immediately stricken out. Other tests borrowed from anywhere and everywhere were added to the scale in the year in which they seemed most appropriate. The distribution of these tests was purely a matter of guess work, and we realized it. After forty or fifty children in the Sunshine Homes were examined it was quite apparent that some of our tests had been placed in the wrong year. I made very little change, however, as I felt that for a long time we must continue to collect data. The test sheets were printed with the view of testing the tests and not the subjects.

Mr. Irwin then had the tests used in Toledo, Cleveland and Pittsburgh and induced the Ohio Board of Administration to employ Dr. T. H. Haines to try out the tests on the pupils in the Ohio State School for the Blind. Dr. Haines published his results (3) and an arrangement of the Yerkes Point Scale for use with blind children in 1916. In the same year two college graduates who had spent an extra year under Dr. Goddard at Vineland, were engaged as assistants at Perkins Institution and at Overbrook, and the testing of the pupils in both schools with Irwin's revision of the Binet tests was begun, at Watertown in the spring, at Overbrook in the fall. Also in the spring of 1916 more than fifty of the pupils at the New York State School for the Blind at Batavia had been tested by Miss Katherine Roese who came to Overbrook as psychological assistant in the fall, and in 1918 the assistant from the Perkins Institution, Miss Edith Taylor, used the tests in the Batavia school again. All together it seems likely that close to 1000 blind children have now been tested by the use of the Irwin-Binet series: the results I shall quote are based upon something over 670 tests in the New York State School for the Blind, the Pennsylvania Institution for the Instruction of the Blind, and Perkins Institution.

Table I shows the results obtained by the use of the Irwin-Binet intelligence tests in three schools for the blind compared with the results quoted by Terman (11, p. 66) after testing one thousand unselected American school children between five and fourteen years of age with his revision of the Binet tests.

A study of this table gives us partial answers to two important questions:—(a) How numerous are the superior, normal, and inferior pupils in schools for the blind? and (b) How effective are the Irwin-Binet tests in distinguishing them?

In general, the distribution of pupils by intelligence is the same in schools for the blind as in schools for the seeing—the great mass of pupils test about at age, and above and below the normal or average group there is a small percentage of mentally superior and mentally inferior pupils. This would seem to indicate that the Irwin-Binet tests, in spite of the fact that their present form is tentative, have been fairly satisfactory in classifying blind pupils. This conclusion is further justified by the comparison of these results with the estimates of the mentality of the pupils made in these three schools by the teachers; in certain individual cases the teachers' judgments differ from the results of the tests, though there is very general agreement even here; but the great mass of the pupils are in each school classed as about normal or average. It seems fair to assume that, with a slight improvement in the arrangements of the tests, a still closer approximation to the normal curve of distribution shown in tests of the seeing may be attained in tests of the blind.

Table I. Frequency of Different Degrees of Intelligence

	School I		School II		School III		Three schools		1000 seeing	
	No.	%	No.	%	No.	%	No.	%	No.	%
Genius?			2	.8			2	.3	5	.5
Very superior	1	.6	4	1.7	2	.7	7	1.	20	2.
Superior	12	7.4	16	6.6	7	2.6	35	5.2	90	9.
Above average	13	8.	22	9.1	9	3.3	44	6.5	115	11.5
Average	116	71.1	155	64.4	193	72.4	464	69.3	760	76.
Dull	20	12.3	31	12.8	33	12.8	84	12.5	80	8.
Border line	9	5.5	19	7.9	19	7.	47	7.1	20	2.
Feeble minded	5	3.1	14	5.8	12	4.5	31	4.6	3	.3
Below average	34	20.9	64	26.5	64	24.3	162	24.2	103	10.3
Totals	163		241		266		670		1000	

How numerous are the superior and inferior pupils in the schools for the blind? The table indicates that superior pupils are much rarer among the blind than among the seeing while inferior pupils are much more numerous. In the three schools seven very superior pupils have been discovered, about 1 per cent of the total number tested; among the 1000 seeing children, 2 per cent or twice as many very superior pupils were found. Among the blind there are more than twice as many dull as there are superior; among the seeing these two groups are about equal. Among the seeing, the very good pupils just about balance the very bad pupils, 2.5 per cent above superior, 2.3 per cent below dull: among the blind we find only 1.3 per cent very good and 12 per cent very poor. The situation is not quite so bad, however, as these last figures might lead one to think; in the last group are a considerable number who were accepted on probation and discharged after their inferiority was demonstrated by the tests and by their inability to accomplish passable school work.

In general, the teachers and superintendents in schools for the blind concede that the tests even in their present tentative form have given a fairly true picture of the distribution of intelligence among the pupils. Very superior pupils are decidedly rare. Whether this is because the most intelligent blind children are more likely to be educated at home, and so do not enter an institution; or because blindness is far less common in the homes of educated and intelligent people than in homes of the other sort; or because blindness is so great a handicap that very few get to the top in spite of it; or for various other reasons, we have not at present the data to decide. The *tests* have discovered very few superior pupils; teachers and superintendents seem equally unsuccessful. Inferior pupils, on the other hand, seem very numerous. Here, again, there are a number of contributing causes. Heredity, poor environment, the fact that there are no homes for the feeble-minded blind, all contribute to make the percentage of inferior pupils much larger than it is in schools for the seeing.

2. *Group Tests of Intelligence and of Other Mental Functions*

When America entered the world war, and the psychologists of America were called upon to devise tests which might be used to classify our draft army according to mental ability, group testing seemed the only feasible method of dealing with the great numbers of individuals in the limited time allowed. The success of the army tests, of course, reacted upon civilian testing, and we now have several sets of group tests of intelligence which may be used for a rapid and fairly thorough mental survey of the school population of whole cities or counties. One of these sets of tests seemed suitable for use with the blind, and the writer has adapted this set and with his assistants carried it through three schools for the blind—the Overbrook school, Perkins Institution, and the Connecticut school at Hartford. The results are not yet completely figured up, but so far as they go, they seem to show a high correlation (at Overbrook the rank order correlation is +.77) with the individual tests of intelligence. The great advantage of a group test is obvious: it requires from one tenth to one twentieth of the time needed for an individual test, thus making a tremendous saving in the time and expense of a mental survey.

The intelligence tests selected for use with the blind were Pressey's (7) Group Point Scale, a series of ten tests in each of which there is a possible score of 20, thus making the maximum total score for the series 200. Pressey has published grade and age norms resulting from the testing of over one thousand unselected seeing school children, so that it is possible to compare the attainments of the blind with those of the seeing. A brief description of the tests will show the method and the mental functions measured.

In test 1, rote or literal memory for words is tested by reading a series of words and asking the subject to write the word which comes after some given word in the list. For instance, I might say, "The first list is: ground, milk, desk, hand. Write the word that came after *desk*." Twenty such lists are given, the first consisting of four words, the last of ten words. In order to give the correct answer to the question, it is necessary to remember the list in its proper order.

The second test measures "logical selection": the subjects are given five minutes in which they are required to select from printed lists of four or eight words, two things which go logically with another given word. For instance, in the following list, "Which two things is a cat never without?—fur, house, milk, claws"; in the next list, "Which two things is a building never without?—windows, wood, chimney, wall, shingle, roof, stairs, shed?"

The third test consists of 20 examples in oral arithmetic.

The fourth test measures a simple reasoning process—the ability to give the opposites to a series of twenty words. For instance, "What is the opposite of poor? of quick? or bless? of if?"

The fifth test measures logical memory. A newspaper article is read to the pupils and twenty questions are asked about the details of the text. All the questions can be answered by yes or no, a name, or a number. Some of the questions are suggestive or misleading and calculated to determine whether the pupils can easily be led astray.

In the sixth test the pupils are given a sheet upon which have been printed twenty words with one or more letters omitted, with the request that they complete the words and write them correctly. Completion tests of this sort have shown a very high correlation with other methods of estimating intelligence.

The seventh test is entitled "moral classification." A printed list of twenty words is given to the pupils, which they are asked to classify in four groups—the things in the list that it would be wrong to do in a school room; the words that mean being good to other people; the words that mean something that is bad for oneself; and the words that mean getting something unfairly from someone else. To pass the test, one must be pretty well acquainted with some long words, such as extravagance, benevolence, forgery, dissipation.

The eighth test is a direct adaptation of a test from the Binet series—the dissected sentence test. Twenty sentences are printed with the words in haphazard order. The pupils are allowed ten minutes in which to read the words, rearrange them mentally into coherent sentences, and write the first and last word of each sentence to show that they have arranged them properly. The sentences vary from three to fifteen words, and a correct solution of some of them makes considerable demand both on memory and on verbal ingenuity.

The ninth test is an attempt to determine the range of everyday information. The pupils are given printed lists each containing five items: "In the following list of animals, which usually lives the *longest* and which the *shortest time*—man, cow, hen, dog, cat?" "In the following list of ways to send money, which is the safest and which the least safe way—bills, coins, check, draft, stamps?" "In the following list, which man must have most skill, and which is the least skilled worker—weaver, cabinet-maker, riveter, typesetter, coal-picker?" In order to make the correct selection in the whole ten groups, a pupil must have been pretty wide-awake, with or without the use of his eyes.

The last test perhaps makes a more explicit demand upon reasoning ability than any of the preceding. Three words are read which stand in some relation to each other: the pupils are asked to write the fourth word to complete the thought. For instance, if I read girl—woman; boy? . . . you at once think of man, because the boy becomes a man as the girl becomes a woman. Another easy analogy is horse—trot; fish ? . . . Another is oyster—shell; banana ? . . . The following make more trouble for the children, like—friend; hate ? . . . little—small; ancient ? . . . water—pipe; electricity ? . . . age—youth; autumn ? . . . .

The Pressey group tests have been used in the schools at Overbrook, Hartford and Watertown, but up to date only the results from the first school have been scored—a total of 122 subjects. These group tests show the same distribution of intelligence as the individual tests—most of the pupils test at average or normal (66 per cent), a few (14 per cent) test a little better and a few (12 per cent) test a little worse than average, while a small number test very good (5 per cent) or very bad (3 per cent). A comparison of the scores of the blind with those of the seeing shows the average attainment considerably lower among the blind. This seems to mean that some of the tests in this series are not suited to the blind, or that not enough time was allowed in tests in which it was necessary for the pupils to *read* the test sheets. This first use of the tests has demonstrated the possibility of sorting out blind pupils as good, average, and poor by means of a group test, a discovery of considerable importance from the practical point of view. When the tests are finally revised, a preliminary mental survey of a school will require only a few days of testing, instead of weeks or months as is necessary with the individual tests. After such a survey, the very high and very low pupils might well be given individual tests to act as a check upon the group tests.

The accuracy of the group tests is indicated in quite another way: an examination of the lists of names in the different groups of scores, shows that in general the same pupils rank high in the group tests who had attained a high mark in the individual tests and were placed high in the lists of estimates by teachers; while, similarly, pupils who came out at the lower end of the series in the group tests were also low in the individual tests and in the teachers' lists.

B. The Psychology of the Blind

Thus far we have been discussing the methods and results of applying to the blind individual and group tests of intelligence. The second aim of the department of research at Overbrook was to see what light could be thrown upon the psychology of the blind through the application of the technique of experimental psychology. Every one who reads about the blind is familiar with the extravagant claims made about their wonderful doings. This blind man has a marvelous sense of touch, that one an extraordinary acuteness in hearing, this one can sort colors by the slight differences in the texture of the fabric or odor of the dyes, that one has a "facial" sense which saves him from bumping into obstacles in his path; here is a man who can remember the names of one hundred people introduced to him at a reception, there is a man who can read or meditate in the midst of the greatest confusion and excitement, here is another who can grasp, remember and carry out long lists of complicated directions. And the public accepts these stories uncritically with a more or less undefined impression that in this way it is giving the blind his due: cut off from the use of his eyes, of course a blind person will use his other senses more, they say, and so these senses will become keener and better servants of his will; the blind must attend better and remember better, because they have to depend upon themselves rather than upon external aids, like books of memoranda and reference, telephone directories, maps, timetables, dictionaries, encyclopedias. Thus the public passes on to the blind as a class all the tales it hears about unusual individuals who happen to be blind. Having no very general acquaintance with the blind, the public does not know or remember that there are blind people who have the added misfortune of being also deaf, that some blind people have so poor a sense of touch that they cannot learn to read with their fingers at all (though they may be taught to read with lips or tongue), that under unfavorable conditions all blind people are likely to run into unexpected obstacles and that most of them would never develop any independence and freedom of movement unless they first adopted a policy of determined physical bravery according to which the bumps and bruises are accepted good-naturedly and perhaps humorously as part of the day's work, that some blind people remember very poorly, are easily distracted by disturbing stimuli, are very poor at reasoning—in other words, that the blind as a class are not prodigies or curiosities but just "folks" like the seeing, some good in one thing, some good in another, probably showing as many degrees of difference among themselves as are found in the larger class of the seeing.

Now, modern psychology is predisposed to take the same attitude on this question that the blind take about themselves. Class or "type" psychology, as it used to be called, is distinctly on the wane. It used to be quite the style to write essays upon the mental characteristics supposed to be peculiar to groups or classes of people. It seems so easy and natural to generalize upon the basis of casual observation, supporting one's hypothesis by every favorable instance and failing to see or appreciate the frequent exceptions to the rule. One travels a bit and writes a book on the national characteristics of the English or the French, the natives of New York or Chicago; the rich are given a list of traits more or less at variance with those attributed to the poor; physicians are assumed to have certain traits, ministers others, and lawyers still others; we speak of the criminal class, the rural and urban types, the married and the unmarried; some rash moderns would classify people into distinct mental classes according to the color of their hair and eyes; others claim that the feeble-minded are really a distinct human species within the human race—a group as distinct from normal people as the black or yellow race is distinct from the white.

But scientific psychology has progressed beyond this stage of reasoning: an era of careful measurement has broken down the class lines based on unchecked observation. Within each so-called "class" one finds wide and varied differences in the degrees and combinations of traits, so that when a whole group is measured, the great mass of the individuals is found to possess only an average amount of each trait, with a smaller per cent of superior and inferior individuals on each side of the middle class. In other words the distribution of each trait is found to make a bell-shaped curve similar to the curves of intelligence for blind and seeing, which could be formed from Table I. Psychology has broken down even such venerable distinctions as the assumed mental differences between men and women as classes.

Among the blind, then, one would not expect to find all individuals exhibiting the same group of mental functions in about the same degree, with a clear line of division between their characteristics and the characteristics of the seeing. One would rather expect that each trait which is susceptible of measurement would be distributed according to the bell-shaped curve, skewed slightly to right or left if the conditions of life require extra use of some characteristic which may be increased by practice.

Two methods may be used to determine the question experimentally: (a) intensive detailed experiments upon a limited number of individuals, and (b) extensive surveys of large numbers of blind subjects in groups.

A notable beginning by the first method has been made by Professor Seashore (9) of the University of Iowa. This psychologist has recently made a careful comparative study of sixteen blind and sixteen seeing subjects to determine the degree of sensory compensation in touch and hearing. He concludes that the blind are undoubtedly superior in the general use of touch and hearing in practical life but that they show no superiority in general sensitiveness when tested in ways of using touch and hearing which they have had no occasion to *practice*. An illustration will make this point clear. When tested to determine the sensitiveness of touch as indicated by the number of sheets of paper through which the subjects could locate a fine wire on a circular glass plate, Seashore found that his blind subjects varied from ten to thirty-eight sheets, the seeing from fourteen to forty-seven. The median attainment of the blind was twenty-five sheets, the median for the seeing was twenty-eight. Hence both in median and maximum attainment the seeing were superior to the blind, in this unpracticed test. On the other hand, many of the blind did better than the median of the seeing group and many of the seeing did less well than the median of the blind group, i. e., the groups overlap and show the artificial character of the division into blind and seeing so far as this ability is concerned. In general, Seashore concludes that the superiority of the blind in the use of the senses of touch and hearing is a superiority in apperception—in the understanding of sensory cues similar to the superiority of the Indian in following a trail, or the sailor in sighting ships at a distance—not a superiority in sensory discrimination itself.

Much greater progress has been made along the other line of research—by extensive surveys of large groups of blind subjects. Among the tests included in the Pressey Group Point Scale of Intelligence described above are a number of tests which will shed light upon the degree of different mental functions at different ages, such as rote and logical memory, association, imagination, simple and complex reasoning, etc. The results of the Irwin-Binet tests may be combined and worked over under the same and other headings. Another group of psychological tests adapted from the work of two well-known psychologists, Pyle (8), and Whipple (12), has been carried through three schools and the results are ready to be used in the same way. An article upon the memory of the blind based on the results obtained in these different ways is now in the "curve stage," so that brief quotations may be made already.

1. The Rote Memory of Blind Children

So far as the work has been carried, no clear superiority of the blind in rote memory has as yet been discovered. Haines (3) thought the blind were decidedly superior in repeating digits—one of the Irwin-Binet tests—but the results at Overbrook show no superiority when the pupils are arranged by physiological age or grade, and only a slight superiority when arranged by mental age. Haines says repeating seven digits is probably an average accomplishment for a ten-year-old blind child: the Overbrook results show no superiority of the blind over the seeing at ten years, both being able to repeat only six digits. When subjects are asked to remember and *reverse* a series of digits, the blind at Overbrook arranged by mental age conform almost exactly to the seeing norms, though Haines again thought he detected some superiority among the blind.

In the ability to remember and reproduce lists of words, as in the Pyle or the Pressey rote memory tests, the blind as a whole show no superiority to the seeing, though there is some indication that if the scores of the low grade pupils are omitted some superiority will be demonstrated.

In logical memory, or memory for ideas, the same general results have been obtained. When asked to reproduce the ideas of a story read to them, the pupils at Overbrook fell decidedly below the seeing standards, even when the blind were arranged by mental age to eliminate the influence of older pupils of small mentality; and when asked to answer questions upon a newspaper article about a fire, in the Pressey series, no superiority of the blind became evident in curves based on physiological age or grade, though the curves based on mental age do show superiority of the blind at most age groups.

C. Experimental Pedagogy of the Blind

This is an era of standardization. There was once a time when people could get along with varied tools and materials—when a cabinet maker was willing to make brass pulls and screws as he needed them for a bureau or a desk, and to fit his nuts to the screws he had made. Many of us can remember the days when each bicycle and wagon had its own peculiar shapes and sizes of parts. Automobiles are still unstandardized in most respects, and so are sewing machines, as some of us have found to our great discomfort and inconvenience. But great progress has certainly been made in many lines and probably another decade will see standard milk and standard gasoline, standard sizes and weights for asparagus as well as eggs, bananas and oranges, interchangeable parts for the automobiles of certain classes, etc. The public schools have felt the movement for years and within the last dozen years a bewildering number of articles has been published describing the measurement of school progress in various subjects by means of standardized tests of attainment. It is no longer sufficient to have someone's opinion that the pupils of a school or city are "doing fine work", one insists on facts. And the facts discovered have often been very startling and productive of radical changes in educational methods and theories.

At the Convention of the American Association of Instructors of the Blind in Colorado Springs in June, 1920, I presented a report upon the use of standard tests of four elementary subjects in schools for the blind—tests of reading, spelling, arithmetic, and language. A few brief quotations upon this work will be given here, with some references to the new work of the past year.

1. Measurement of Reading

Reading is perhaps the most important means of intercommunication in civilized society. The attainment of facility in reading is everywhere considered a fundamental duty of the child in school. How well do blind children read? Is touch reading so difficult that speed is out of the question? How well do blind children comprehend what they read? Do they remember what they read?

The study of reading among seeing children has shown that reading with the eyes is a relatively complex procedure, and that it is easy to form habits which greatly hinder effective reading. An analysis of the mental processes involved in getting meanings from printed words shows further dangers and difficulties. A considerable number of tests has been devised to bring one or another factor into prominence, with the hope that full knowledge may suggest remedies. Silent reading proves to be a very different process from oral reading, and facility in each is tested by appropriate methods.

A fundamental factor of one's ability to read silently is the range of words whose meanings he recognizes. Hence various vocabulary tests have been devised to measure the pupil's ability to associate the appropriate meanings with printed words.

The speed of reading and the comprehension of what is read are the points one ordinarily has in mind when asking how well an individual or a grade can read. Three types of tests have been widely used to measure the ability of seeing pupils:

Tests for the understanding of sentences or paragraphs without regard to the time required for that understanding.

Tests which measure *separately* the speed of reading and the amount of comprehension.

Tests which combine the factors of speed and comprehension in a single score.

Tests of the second and third groups have been used in Batavia, Hartford, Watertown, and Overbrook. The results will be briefly summarized.

The Courtis silent reading tests were used at Overbrook in the spring of 1917 and the results presented in the report on reading published at Overbrook in June, 1918, as pamphlet No. 1 of the Department of Psychological Research (5). The purpose of this test was to find out how rapidly and how well blind pupils read so that we might know whether they were at a disadvantage in other tests in which rapidity was a factor. As the work progressed it became evident that the material collected might be used for a study of the factors involved in failure or success in reading and for the determination of tentative standards of attainment for blind readers.

The handicap of touch reading became evident at the first examination of the results: the blind pupils tested read the simple story used less than one-half as fast as seeing children in the same grades; they must therefore be allowed at least twice as much time as seeing children in any tests requiring the use of embossed sheets. Of the hundred and twenty-three pupils tested, the large majority read from forty to ninety words a minute, there being only thirteen who fell below thirty, and thirteen who exceeded one hundred words per minute. The fastest readers attained a rate more than ten times that of the slowest—a variation from twelve to one hundred and thirty-five words per minute. Seeing pupils read this story at an average rate of eighty-four words per minute in the second grade, one hundred and ninety-one words per minute in the sixth grade.

The Starch (10) silent reading test was used at Overbrook primarily to see whether the blind would show the same inferiority to the seeing when tested in a different way. The test was then repeated in Batavia, Watertown, and Hartford to see whether there was a difference in the reading ability of pupils in different schools. The Starch test differs from the Courtis in that here a *graded* series of passages is used for the different grades.

The results show a still more marked inferiority of the blind in reading at Overbrook, and a similar slowness of reading in the other three schools. In all the schools the pupils read at *less than one-third* the rate for seeing pupils through all the grades tested. The curves for Watertown and Batavia, moreover, are practically identical, though the pupils were tested with braille in Watertown and with New York point at Batavia. The results as a whole indicate that under present conditions, blind pupils attain at the end of their elementary school work a rate of reading only about one-third of that of seeing pupils of the fifth grade, and that they make no appreciable advance during the high school years.

Is this the best that can be done? Are we justified in requiring blind pupils to undertake the difficult and tedious process of learning to read with the fingers, if we cannot bring their average rate above sixty words per minute? How many graduates will continue reading if they must read so slowly? Have you not known many blind people who make no pretense of reading to themselves just because they never attained ease and facility in their school reading?

The tests have shown the state of affairs. An explanation of the slow rates of reading has been attempted, though various factors await further study. The next step is to determine methods for improving the rate of reading, so that the slow or average readers may be encouraged and helped to attain a facility more nearly equal to that of the best readers—the 5 per cent who reach a rate of eighty or above.

2. *Measurement of Spelling Ability*

In recent years there has been much discussion upon the spelling of school children. Many critics have claimed that with the enrichment of the curriculum too little attention is being paid to fundamental subjects like spelling, and that as a result we have in America today a nation of bad spellers. Scientific students of the subject, on the other hand, have attempted to find out by standard tests just how well or how badly the children do spell, to determine what ought to be expected of children, and to suggest methods of attaining the desired goal. In the last generation, a good speller was one who could "spell down" a long row of his fellow students, quickly and correctly spelling all sorts of strange and unusual words culled from spelling books and dictionaries by industrious advocates of the system. Today several types of good spellers are recognized. The ability to spell when the whole attention is focused upon the spelling is quite a different thing from the automatic spelling of words when the attention is focused upon ideas which are being expressed in writing. Surely a stenographer who can write business letters at high speed without making mistakes in spelling ought to be called a "good speller" even though she may not be able to spell the unusual words selected for a "spelling bee." And ought we not to class as good spellers those whose written word seldom if ever exhibits mistakes because they quickly *recognize* misspellings and have an ideal of correct spelling which leads them to use the dictionary whenever they are uncertain about a word? In other words, should we not judge people by the written output, rather than by an artificial test like the old fashioned "spelling down"? As we have no records of the spelling of pupils in earlier days, based upon uniform standard tests, one cannot be sure that the prize speller was any commoner in past decades than at present. On the contrary, there seems to be a considerable indication that good or bad spelling "runs in families" more or less independent of educational emphasis upon the subject, so that one might expect a fair sprinkling of good spellers in every generation. And, secondly, the recent psychological study of the spelling process has led to suggestions which may well result in raising many poor spellers to average, and average spellers to good spellers.

a. The Ayres spelling scales (6, p. 115).—

> It appears to be the consensus of opinion among modern students of spelling that one needs to be able to spell correctly the words used frequently, with a minimum of attention or automatically, as is the case in writing letters, compositions, school exercises and the like. Otherwise it is impossible for one to focus his attention upon the ideas which are being expressed. In addition, it is desirable that one should be able to spell a number of words which are used only occasionally. In the case of the more difficult and unusual of these words, it is probably sufficient if one is able to spell them correctly when attending to them. (6, p. 112.)

Ayres undertook to determine what words are most commonly used, by examining business and family letters, newspapers and selections of standard literature. The material collected gave a total of 368,000 words written by 2500 different persons. From this great mass of material Ayres selected the thousand words which were used the most times, divided them into lists of twenty and had them spelled by public school children in various cities. In all 70,000 children spelled twenty words, making a total of 1,400,000 spellings, or an average of 1400 spellings of each of the thousand words. On the basis of these results Ayres classified the words in twenty-six groups, the words of each group being of approximately equal difficulty for school children of a given grade, as indicated by the number of failures. This classified list, with the per cent of pupils in each grade who spelled the words of each list correctly, has been published as the Ayres Measuring Scale for Ability in Spelling, and is widely used in school surveys. To test a grade or an individual, one need only select twenty words from one of his lists and see whether the per cent of words correctly spelled equals the standard per cent for pupils of that grade. The words may be given as isolated words, they may be imbedded in sentences which are dictated, they may be given in sentences dictated at a standard rate with the expectation that some words must be omitted by the slower writers. This last form of the test approximates most nearly the spelling of every day life, where the attention must be directed to the ideas to be expressed lest they be forgotten. The words of the Ayres list constitute over 90 per cent of the words we use. Hence by using the words embedded in sentences and dictated rapidly enough to force the child to write at his normal rate, we measure the spelling ability which functions in everyday writing.

The Ayres words have been used by all three methods in spelling tests at Overbrook, and by the first two methods at Perkins, Hartford, and Batavia.

Spelling tests with twenty isolated words from the Ayres lists and with groups of his words embedded in sentences showed the schools somewhat below the standard for seeing pupils. But when one omits the scores of the pupils classed as borderline and feeble-minded—a group which is decidedly more numerous in schools for the blind than in schools for the seeing, where the norms in spelling were established—one finds that the blind compare very favorably with the seeing in their spelling of simple, common words.

b. The Starch spelling scale (10).—Starch attempts to measure the *extent* of spelling ability—to determine not how many commonly used words the pupils can spell correctly, but what proportion of all English words they can spell. His test differs from the method used in "spelling down," however, in that he selects his words from the dictionary by chance instead of intentionally picking out the rarest and most difficult. Using Webster's New International Dictionary, 1910 edition, Starch copied out the first defined word on every even-numbered page. He then discarded technical, scientific and obsolete words, and arranged the six hundred words remaining in alphabetical order according to the number of letters they contained. From this long list, six lists of one hundred words each were then formed by taking the first, seventh, fourteenth, etc., for one list, the second, eighth, fifteenth, etc., for the second list, and so forth. He thus had six lists made up at random from the nontechnical words of the English language.

Starch's first list of one hundred words was used at Overbrook in the spring of 1917 and at Perkins in 1919. In giving the test each word was pronounced once, distinctly, then used in a sentence, and then pronounced again, that there might be no uncertainty as to just what word was to be spelled. Sufficient time was allowed for all to finish each word, before another was given.

The results show the decided inferiority of the blind at Overbrook in spelling the hundred widely different words included in the Starch lists, and that this inferiority remains when the scores of the low grade pupils are omitted as above. The cause of this inferiority must probably be sought either in lack of practice or in the methods of teaching spelling. What a pity all blind children are not endowed with the wonderful memory attributed to the blind by the sympathetic public!

They probably get much *less* practice, when they really need more. Not only do blind children begin school relatively late and thus lose the earlier years of school drill, but they read slowly and much less widely than seeing pupils, thus missing the chance to "pick up" the spelling of words which do not happen to occur in their spelling lessons and to review words partly learned. Whether they gain or lose in spelling through their inability to read advertisements on bill boards, in the street cars, newspapers and magazines is a debatable question as is also the claim that the practice of writing with contractions may have a deleterious effect upon spelling.

c. Spontaneous or incidental spelling.—An interesting side light upon the spelling of pupils may be obtained by an examination of their written products when the *spelling* of the words is not in the focus of attention. For this purpose, a certain amount of the material collected in other tests will be examined and marked for spelling. Brief quotations will be made from the results of a single test—one given at Overbrook and at Watertown, to determine how many monosyllabic words could be retained long enough to get them written down. Thirty of the sixty-six words were misspelled by one or more pupils, though the list consisted of such words as the following: cat, tree, coat, mule, bird, cart, glass, long, wet, fierce, white, cold, etc. One is prepared to find occasional phonetic misspelling like "sower" for sour, "fense" for fence, "durt" for dirt, "ruff" for rough, "flor" for floor, etc. It is perhaps not surprising that a common word like tight should be spelled incorrectly in four different ways by eight pupils—tite, thight, tipe and tigh. But the variety of ways in which mule and fierce could be misspelled certainly exceeded expectations—muel, mul, muwl, mewel, mewl, mue, mueul, and mual; ferce, fearce, firce, fierct, feerce, ferse, frese, fearise and faishsess! When the results of a considerable number of tests have been examined for spelling, one ought to be able to form a fairly accurate picture of the automatic spelling ability of the pupils tested, lists of words for special drill may be drawn up, and the types of words, or classes of errors which need special attention determined. Jones has drawn up a list of one hundred common, but frequently misspelled, words which he calls the "One hundred spelling demons of the English language" (6, p. 133). It will be instructive to compare our list with his.

3. Measurement of Arithmetical Ability

The modern study of arithmetic has made it plain that arithmetical ability consists (1) in facility in performing a group of fundamental operations with speed and accuracy and (2) in reasoning ability in deciding which operations to use. Tests have been devised to measure both types of ability.

The fundamental operations should be performed rapidly and with a minimum of attention, i. e., automatically. In adding, multiplying, etc., the results should come to mind as soon as the figures involved can be read. The pupils must not stop to think out the result: it must come automatically.

Moreover, in each of the four fundamental processes, there are numerous specific processes, each of which must be reduced to a habit. For instance, "it is obvious that the ability to add a column of three figures is not the same as the ability to add a column of twelve figures. In adding a column of figures it is necessary that one hold in mind the partial sum until he has added the next figure. This process must be repeated continuously until the final sum is reached, and a failure to do this continuously will result in stopping the adding, at least temporarily. It is a frequent occurrence, for one who is not accustomed to adding long columns of figures, to find that he has stopped, perhaps has even lost the partial sum, and must begin again. The span of attention required in adding three figures is short, and the pupils who are able to do examples of this type with a high degree of skill frequently are unable to add long columns of figures with an equal degree of skill. In fact we have no reason to expect them to do this type of example until they have practiced upon it." (6, p. 19).

Courtis has identified twenty-five distinct types of operations with integers, each of which must be initiated separately by the teacher—seven kinds of operations in addition, three in subtraction, six in multiplication, and nine in division. I quote the operations in addition:

Combinations of two figures
Single column additions of three figures
"Bridging the tens"
Column additions of seven figures
Carrying
Column addition with increased attention span—thirteen figures
Addition of numbers of different lengths.

Each of the twenty-five types of operations requires a specific habit or automatism. To be sure, certain elements, such as the fundamental combinations, are common elements, but careful analysis will show that the ability to do examples of one type is different from that required to do another. Measurement of arithmetical ability, then, involves determining at what rate and with what accuracy pupils are able to do examples of all the different fundamental types. Of course one may test several abilities with one type of example—the addition of figures in three columns of nine figures each included the addition combinations, simple column addition and carrying—but if the pupils do not succeed with this type of example, we must retest them with examples involving only one type of operation to locate their weaknesses.

a. The Courtis standard research tests, series B.—The Courtis tests of the fundamental operations in arithmetic have been quite widely used, so these were selected as our first tests in Overbrook. Only the tests in addition and subtraction have been carried through the grades. After preliminary explanation, sheets were passed around upon which were printed in braille a large number of examples in addition, consisting of three columns of nine figures each. At the bottom of each column was a raised line to indicate the end of the example. The pupils were instructed to begin at a signal and work the examples as rapidly and accurately as possible for eight minutes, writing their results upon their braille slates or typewriters. The examples in subtraction, consisting of two numbers of eight or nine figures with a raised line below each pair, were presented on another sheet, with similar instructions and a time limit of four minutes.

No boy nor girl in the school measured up to the Courtis standards for seeing pupils in addition or subtraction nor equalled the standards published in Boston after the use of the tests there. But this is not surprising when one considers that the rate of reading by touch is so much below that of reading by sight. To make a fairer comparison, it seemed best to use as a standard for the blind, one half the quantity of work with the same grade of accuracy. Upon this basis it was found that seven pupils, out of the ninety-four tested, graded up to the standard—five in addition and two in subtraction.

The papers were then scored for accuracy, marking them according to the per cent correct of those examples tried. These results were arranged by grades and put into curves. Only three grades approximated a passing mark in addition and one in subtraction, setting the passing mark at from 60-70. The curve shows an upward trend in addition from the third to the eighth grade, dropping again conspicuously at the ninth. This type of addition was evidently much too difficult for the third and fourth grades, three fourths of the third grade and one half of the fourth grade scoring at zero. The curve for subtraction follows a similar course up to the sixth grade, and then drops for the higher grades. The third and fourth grades show the same large number of zeros, and the ninth grade shows ten zeros out of twelve tested. One of these students informed the examiner that he had completely forgotten how to do subtraction!

When the results were arranged by sexes, no great difference became evident, except that the girls of the fourth grade were conspicuously better than the boys. In the middle and higher grades the boys seem slightly better both in addition and subtraction.

At first glance these results would seem to indicate that these blind pupils were very deficient in addition and subtraction, though the tests as given do not show the exact type of deficiency. There is a considerable probability, however, that there was something in the way the test was given which prevented the blind pupils from demonstrating their real ability in these fundamental operations. We know they read slowly: possibly they read numbers much more slowly than letters and not so accurately, so that their low grades may be due to inaccurate or slow reading rather than to lack of facility in adding or subtracting the figures themselves. To meet this difficulty another type of test has been devised, but not yet carried through the school and tabulated. In this test the subject will first be asked to read a long series of pairs of figures as rapidly as possible. From this one can calculate the rate and accuracy of reading. Then the pupil will be asked to read and add, or subtract, multiply or divide, the rate and errors being recorded as before. Finally, the pairs of figures will be read to the pupils, whose sole task will be to perform the arithmetical operation demanded. As a result of these tests it is expected that we shall be able to determine why the pupils did so poorly in the Courtis arithmetic tests—whether it was a question of the rate and accuracy of reading, whether the automatic processes in addition and subtraction had not been sufficiently perfected, or whether the blind pupils had not had enough practice in reading and adding columns of figures, or in subtracting embossed examples and writing the results.

Data from another source seem to indicate that the difficulty was probably more with the method than with the arithmetical ability of the pupils. There are a few examples in arithmetic in the Irwin-Binet intelligence tests, placed in Year XVI. Haines reports that these examples are too easy for blind pupils of this age and suggests that they be placed in Year XIII. The results at Overbrook point in the same direction: the blind seem to be two or three years ahead of the seeing in this test. This test consists of three examples which are given orally, a method with which the pupils are very familiar through long practice.

One of the tests in the Pressey series consists of twenty examples of graded difficulty given orally, and here again the pupils at Overbrook test at or above the seeing standards in seven out of ten of the age groups.

At this point one is inclined to raise the query whether there is really any point in trying to teach blind children to study arithmetic beyond the limits of oral arithmetic. On the old theory of mental discipline one might contend that complicated written arithmetic is just as necessary a part of the blind child's education as it is of that of the seeing child. But if we accept the very general belief of educational psychologists, that arithmetical ability is not a general capacity developed equally well by any kind of exercise, but a complex group of specific abilities each of which must be independently developed by attention and practice, there would seem to be no point in requiring blind pupils to pursue mathematics after they have attained facility in the processes they will use in daily life outside the schools.

b. The Courtis test in arithmetical reasoning (Series A, No. 6).—In examples of the problem sort, it is necessary to determine first what operation shall be performed. The psychological analysis of this division of arithmetic has not been carried as far as in the case of the fundamental operations, but it seems plain that here knowledge and simple reasoning, rather than specific habits, are involved. A number of tests have been devised to measure reasoning ability in arithmetic.

The Courtis test has been used at Overbrook. In this test a sheet of problems is passed around with the instruction that the pupils shall read through an example, make up their minds whether the problem is to be solved by addition, subtraction, multiplication or division, and write one of these words opposite the number of the example without solving it. Double the time set for seeing pupils was allowed and yet the blind averaged about two years behind the seeing in speed and accuracy. It is a little difficult to see why one should find this large difference, for the test would seem to approximate the ordinary class work of the blind pupils. Later a similar test will be given in which reading will be entirely eliminated by having the problems read by the examiner.

4. Measurements of Language Ability

Verbal language is concerned with the communication of ideas and feelings by means of words. The choice and arrangement of the words give language its form: the ideas and feelings to be expressed may be described as its content.

The rules of grammar definitely prescribe many items of form. The pupil must attain such perfect control of the correct usages that his thoughts will be expressed in proper form automatically, so that his attention may be focused upon the content of what he is trying to say. The measurement of language ability thus becomes the measurement of specific language habits, resembling the measurement of the different types of habits involved in the fundamental operations of arithmetic.

Rhetoric treats of the choice of words and the structure of sentences and paragraphs, but it does not prescribe definite objective standards for them. The quality of these features of form is determined by the effect of the language upon the reader, and this effect is not the same for all readers. However, rhetoric does furnish certain general principles which are useful to the pupil in guiding his construction of a form which will attain his purpose. Here the problem of measurement is different and more difficult. The functioning of the principles cannot be reduced to the plane of habit, because it is necessary that they function in a variety of new situations.

The content of language is subtle, and is not objective except as it is given a form. It depends upon the vividness and the organization of ideas, and upon the wealth of associations which give the central ideas their setting. These features of content are expressed through the choice of words and the structure of sentences and paragraphs. In this way content and form are so intimately connected that aside from the features of form which are specified by the rules of grammar, any attempt to measure one is made difficult by the presence of the other. (6, p. 193.)

a. Measurement of general language ability.—(1). The Hillegas-Thorndike scale (10, p. 132).—Measurement of ability in English composition consists of a series of school compositions carefully graded in percentages and arranged in a series from poorest to best. To measure the ability of a group of children, all are asked to write compositions on a set subject, within a prescribed time limit; their compositions are then scored by comparing them with the scale regardless of their school grade and giving them the same percentage as that of the composition in the scale which they most closely resemble.

The pupils of the Overbrook school were asked to write compositions with the following instructions:

> I am going to ask you all to write me a composition upon the same subject. Fifteen minutes will be allowed for this work. When I have announced the subject, you will begin at once and continue until I give the signal to stop.

The pupils wrote upon the topic—"The book I have enjoyed most this year." Twenty-six boys and thirty girls were tested, from the fifth to the ninth grades inclusive.

The compositions were scored by a woman who has given much attention to writing but was not personally acquainted with any of the pupils. The results were arranged by grades and thrown into curves. In comparison with the standards proposed for seeing children, the blind pupils show no inferiority but rather a slight superiority, more marked among the girls than among the boys. In many of the compositions there was evidence of quotation of common phrases and bromidic padding; in one of the boys' compositions the author attempted to quote verbatim the text of a poem he had been committing to memory, but without marked success. Several of the boys explained their choice of a book to discuss by confessing that it was the only book they had read in the year—an interesting side light on the question of reading!

(2). The Trabue completion-test language scales. (6, p. 210).—These scales consist of series of sentences from which one or more words are omitted. The position of the omitted word is indicated by a blank. The pupils being tested are asked to write in the missing words in a certain limited time. The relative difficulty of the sentences has been determined and they have been arranged in order of difficulty. The score is determined by the number of sentences that can be satisfactorily completed. These tests may be given to blind pupils by presenting the text in braille and asking them to write on their slates or typewriters the words that should be supplied. The test is considered also as a measure of the intelligence of the pupils.

b. Measurement of specific language habits.—(1). Starch's grammatical scales (10, p. 101).—The purpose of these tests is to determine whether pupils are able to use language forms correctly. In giving the test to seeing pupils printed copies of the scale are passed around with the following instructions: "Each of the following sentences gives in parenthesis two ways in which it may be stated. Cross out the one you think is incorrect or bad. If you think both are incorrect, cross both out. If you think both are correct, underline both." The pupils are given as much time as they need. The sentences have been carefully graded and arranged in an ascending scale from simplest to most difficult. The pupils' score is the value of the highest group of sentences in which he does three out of four correctly.

In giving this test at Overbrook, the writer read the pairs of sentences aloud to the pupils and asked them to write upon their slates or typewriters, the number of the sentence and a word or two to indicate which of the two renderings seemed to him preferable, if there was a choice; to write both correct or both incorrect, if that was his decision upon them.

5. Summary

The use in schools for the blind, of standardized tests of school subjects is still in its first or experimental stage. Enough has been done to show that by a careful adaptation of methods to the necessary limitations of pupils deprived of sight it will be quite feasible to measure a considerable proportion of the attainments of pupils in school. Undoubtedly the standards will not be the same as those for seeing pupils and it may take a considerable time before it will be safe to set standards for blind pupils. In such an effort the co-operation of many schools and persons interested in the education of the blind is essential. Preliminary surveys should show what the schools are actually accomplishing in the attempt to educate blind pupils. A comparison of results in different schools should lead to tentative standards for all towards which the less successful might then strive. A careful analysis of failures, difficulties, and impediments might lead to helpful suggestions for improving methods of teaching, and the ultimate attainment of results which would justify the establishment of permanent high standards.

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VIII

Preliminary Study of the Influence upon School Success of the Age at Which Vision Is Lost

THE SUBJECT OF THIS PAPER is part of a much larger topic upon which there is an abundance of warmly held opinion, but very little experimental evidence—the effect upon life and character of an early deprivation of vision and the loss of visual imagery. The general opinion is well expressed by Haines (4, p. 78) in attempting an explanation of the difficulty the congenitally blind have in pointing out the cardinal directions.

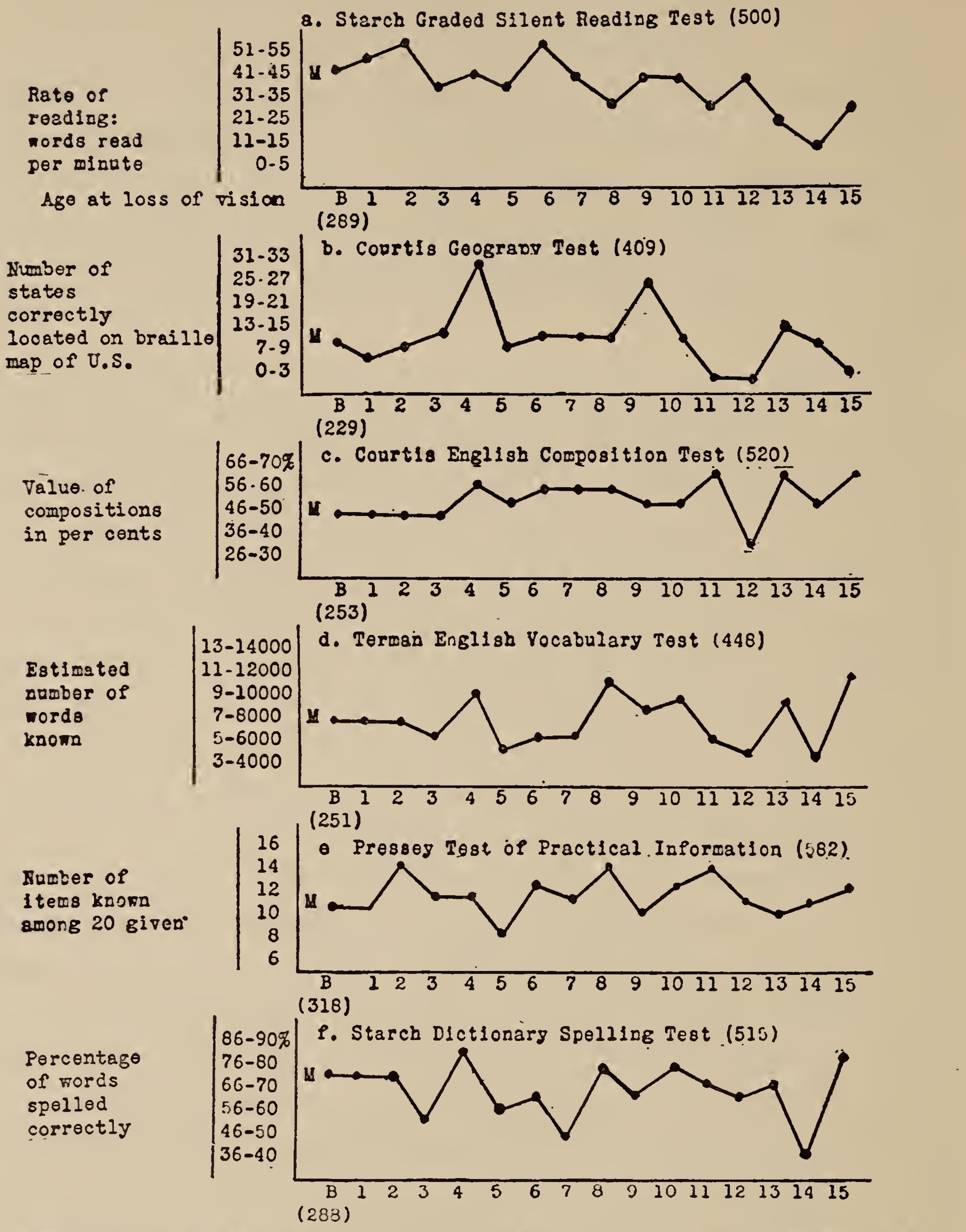
> We encounter here a real difference between the mental processes of blind and seeing subjects. Without vision it is impossible to get the same conceptions of space, and those space conceptions which are developed will be matured much more slowly. This is partly because human space conceptions utilize visual imagery,—in fact are largely visual schemata,—and the blind must find their own tactual and inner tactual substitutes for these, in order to construct the spatial aspects of their own experience, and come into possession of a framework upon which they can organize the communications of seeing subjects, and the literature they read.

Haines considers the group of people who are totally blind from birth or shortly after, to be the typical blind, and plans to standardize his tests on the basis of his results with these subjects. Drummond (3) takes the same position. S. C. Swift (9) makes a fundamental distinction between those born blind and those who have enjoyed vision long enough to gain and retain visual images, and maintains that the "variations between the mental processes of the normal and those of the non-visualizing blind man are sufficiently numerous and striking to constitute a special branch of the science of mind," these variations not being limited merely to intellectual processes like the perception of space relations, but frequently causing real difficulties in social adjustment and marked changes in character qualities. And I might quote a considerable list of similar opinions, which are well reasoned as far as they go, but which seem to me to *raise,* rather than to settle, the question, because their position is theoretical and general rather than the result of an experimental attack upon the particular problem they discuss.

The Director of Perkins Institution, Mr. Edward E. Allen, wrote me that he had just been reading a number of German publications in which great emphasis was put upon the distinction between the "congenital" and the "adventitious" blind, and that this had set him to wondering whether we, in this country, were not insisting too much upon a uniform system of education for the two classes. "Do your tests differentiate these classes, and have you formed any opinion on the point thus brought out?" he asked me. This paper is my answer.

In the survey of seven schools for the blind in 1919-20, and the similar tests conducted in two other schools in 1920-21, we accumulated data which may be considered as fairly representing the mental and educational attainments of nearly six hundred children of different degrees and years of visual experience. In response to Mr. Allen's question, this collection of data was worked over to discover whether there was any real difference in the achievements of children who lost their sight at different periods of their life, and the curves resulting are shown below. All these curves were formed in the same way. The record slips were first sorted into piles, according to the age at which vision was lost, the first pile including those born blind or who became blind within one month of birth; the second pile, those who lost their vision within the first year; the third pile, those who lost their vision during the second year, etc., up to pile 15, which included all blinded after fourteen years of age. These groups are indicated by the figures under the horizontal lines, and below "B" is given the number of cases in the first and largest group. In the columns between the vertical lines, I have indicated the degrees of efficiency in the test, sometimes showing the actual number of items—the number of words read in a minute, or the number of states correctly located on a finger map of the United States—sometimes giving the per cent of correctness or of value as compared with certain objective standards. The curves then show the average attainment of each age group. The median, or middle, attainment of the whole number tested, is indicated in each test by a letter "M" opposite the appropriate point in the vertical scale of efficiency.

Curve "a" gives the results obtained by testing five hundred pupils in eight schools for the blind, using Starch's graded silent reading test from the fourth grade upward, [all the tests mentioned in this paper are fully described by Hayes (5)]. It is often said that children who are totally blind give themselves up more readily to the task of finger reading than those with a little vision and hence learn to read more readily, and that those born blind similarly adjust themselves with better grace and more rapidity to the use of the fingers. We have considerable evidence that both these propositions are true, though curve "a" applies only to the latter statement. There is a decided downward trend to this curve, and if one were to smooth it out by taking medium points between the extremes of the successive age groups, the trend would be still more marked. More than half the whole number tested are included in the "born-blind" group, and if we were to include with them the one, two, and three year groups, who are probably like the first group in lacking visual imagery and living a typically "blind" life, we should have a very large percentage of the good readers. When the results are presented in "scatter diagrams," in which the individual scores are represented by dots distributed in a table according to rate of reading and age at loss of vision, our points become still clearer. The scores of those born blind are distributed quite regularly and according to the normal curve of frequency, there being a few very excellent and very poor scores, more of the good and poor scores, while the great mass of scores is clustered about the median. The



"M" indicates the MEDIAN attainment of the whole number tested in from 7-9 schools.
Under "B" is given the number blind at birth or 1 month.

CURVES TO SHOW THE INFLUENCE UPON SCHOOL ACHIEVEMENT OF AGE AT WHICH VISION IS LOST general superiority of those born blind is indicated by the fact that the median for this group is higher than the median for the rest, and by the fact that most of the very good scores are credited to pupils blind from birth—eighteen out of the twenty-four who read at the rate of eighty to one hundred words a minute (which is about twice the rate attained by the whole number tested), lost their vision within the first two years.

Curve "b" shows how well blind children are able to locate states on a finger map of the United States. This test is given by passing out paper maps upon which are embossed only the state boundaries, a few important cities, and key numbers. The states are called in irregular order and the pupils asked to locate each state, to read the number printed in it and to write the number on their slates, as evidence of their knowledge. The curves for this test have been very irregular whether formed from groups sorted by age, grade, or age at loss of vision, and inquiry showed great variety in the extent to which maps had been used in the different schools and grades. The main point, however, is sufficiently clear in curve "b": well over half the pupils tested had lost their sight at birth, and yet their ability in locating states is just equal to the median attainment of the whole number tested. Moreover, a considerable number of the best scores were made by pupils of the early groups: of the fifty-five pupils who scored above 30, the highest point of the curve, thirty-nine lost their vision under the age of five years. Here is an answer to the question whether children without visual imagery can use maps: *these* children *can* do so, and probably others would do as well if they were systematically taught to use them. *How* they do it is not known, but it may be possible some day to find out by an introspective study of the problem. The theoretical difficulty is well expressed by the psychologist, William James (6, p. 206):

> I am disposed to believe, after interrogating many blind persons, that the use of imaginary maps on a reduced scale is much less frequent with them than with the rest of us. Possibly the extraordinary *changeableness* of the *visual* magnitude of things makes this

habit natural to us, while the *fixity* of *tactile* magnitudes keeps them from falling into it.

How children blind from birth are able to recognize the shapes of states on a map of a different size from the one they used in learning the states is certainly a puzzle, but if some pupils could locate over forty states, surely the median attainment ought to be well above the modest eleven discovered in our tests.

Curve "c" shows the results of a test in which the pupils were asked to write a composition, under practically the same conditions as in everyday school work. Here we notice a slight upward trend from the early to the later groups, those blinded at birth being a little below the median for the whole number tested. This fits in rather well with popular opinion. Those who may be disposed to recommend a literary career for a capable congenitally blind pupil may well ponder Jastrow's (7) criticism of the early writings of Helen Keller:

> The mental canvas, though conveying a similar impression, is not suffused with the glow of vivid life likeness, with the warm and rich reality of experience. The normality of the intellectual life of a blind-deaf person is largely the resultant of the community of expression with that of the seeing and hearing. The same language is used, but the richness of the verbal associations, their color and flavor, must inevitably be paler and more meagre, and in certain directions defective and false.

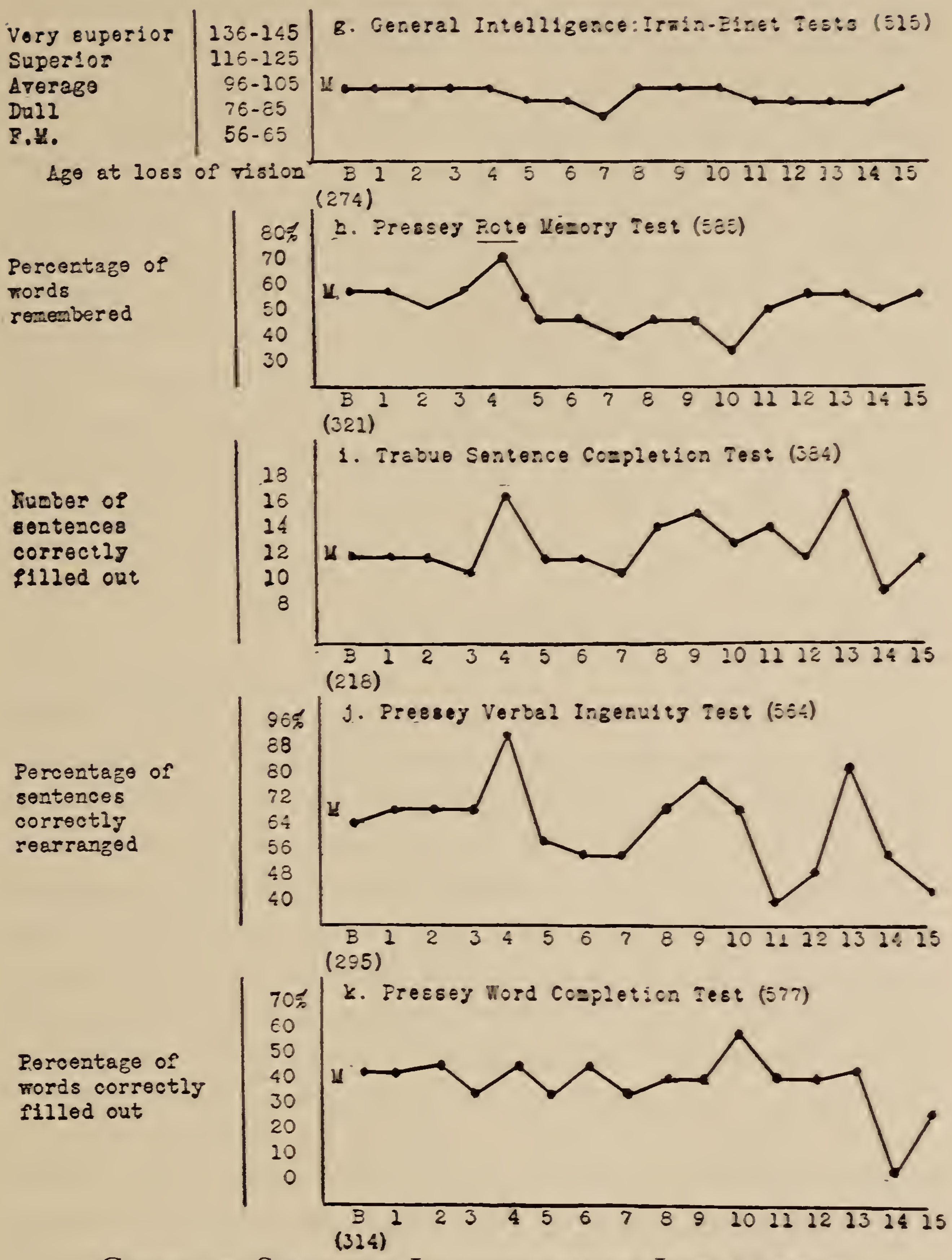
Swift (9, p. 44) writes in similar vein: "Limited imaginative power and consequent poverty of creative expression are characteristic of the mental life of the non-visualizing blind," he says, and he calls upon his readers to cite a single instance of a successful lyric poet, novelist, historian, or descriptive writer among those lacking visual imagery. On the other hand, one must bear in mind that the curve shows only the median attainments of the groups, and that within each group there are great individual differences. When the results of this test are presented in a scatter diagram to show the individual scores, we find that pupils blind from birth wrote compositions which were judged all the way from 10 to 90 per cent when compared with standard compositions written by seeing pupils, and that of the twenty-three compositions graded above 75 per cent, fifteen were written by pupils who lost their sight within the first two years of life. These compositions by 520 blind children are quite inferior to those of the seeing as a whole, showing only a fair organization of material, a commonplace content lacking in interest, little imagery of any sort, and an artificial and forced use of visual terms, a barren vocabulary largely limited to two-syllable words with little indication of an appreciation of fine distinctions of meaning, and only in the rarest cases exhibiting originality or literary merit. If this picture is a fair one, the need for further analysis of the difficulty is obvious: the lack or loss of visual imagery in the early years does not prevent *some* individuals from succeeding in their compositions; why then do we find a general retardation of four or more years?

Curve "d" shows that those blinded early in life have managed to acquire about as extensive a vocabulary as those who have had some years of seeing experience. The great irregularity of the curve is perhaps due to the fact that *life age* is more important in determining size of vocabulary than the age at which vision was lost. Curve "e" shows that there has been no marked difference in the ability to accumulate everyday facts between those losing their sight early and those who have had vision for a few years. Curve "f" again shows no general superiority in spelling as a result of the enjoyment of vision, the early groups here, also, testing up to the median of the group. On the whole then, for this series of tests of typical school subjects, the early loss of vision and visual imagery has *not* resulted in inferiority in school achievement; without the aid of a mental function which to its possessors seems essential, this group has managed by some means to hold its own with the rest in the schools. Can it do the same in life?

One is often asked whether children in schools for the blind are as bright as seeing children, and especially whether those who are blind from early infancy can overcome their great handicap and take their proper place with the rest. We have not as yet any final answer to the first question: both our individual and our group intelligence tests have been adjusted so that they can be given without the use of the eyes, and our effort has been to make them fair to the blind rather than to use them as a means of comparison with the seeing. The following curves represent an attempt to answer the latter question; they present the results of the Irwin-Binet individual intelligence tests and a number of group tests of memory, imagination and simple reasoning, which show a high correlation with general intelligence.

Curve "g" indicates that there is no variation in general intelligence with the age at which sight is lost. The two parts of the curve which fall below the median level are probably to be explained by defects in the tests which as at present given, seem to be less fair to the older than to the younger children, though the fact that the curve as a whole is close to the level of average ability speaks well for the general success of the tests. In any considerable group, of course, the large proportion of cases should show average attainment, whatever the test. A scatter diagram shows that of the forty-two pupils of superior ability, thirty-four lost their sight before the fourth year, a pretty direct proof that early loss of vision does not cause permanent mental retardation.

Memory is essential to any kind of mental activity and in general there seems to be a close relation between retentiveness and general intelligence. To be sure, there are occasional cases of unusual memory with low grade intelligence, like the blind boy reported by Principal Battles (1) who could tell the contents of every chapter in the Bible, though unable to understand the meaning of much that he recited. Byrd (2) reports a similar recent case with vision. But with the general run of children there is a gradual development of retentiveness with increasing age, and some simple test of rote memory is included in most series of intelligence tests. (Terman, 10). Curve "h" shows the results of a test of retentiveness included in the Pressey (8) Group Point Scale. In this test, the blind children



Curves to Show the Influence upon Intelligence of Age at Which Vision Is Lost get a decidedly higher score than seeing children, perhaps because they have found it necessary to attend to what is said more conscientiously than the seeing child who may more conveniently look things up for himself; and those who have lost their sight in the early years do much better than those who have had vision for five years or more, as is quite plainly shown in curve "h". All the highest scores were obtained by children who lost their vision under three years of age. We have been puzzled to note the frequent rise in these curves at the fourth year. Possibly these peaks are simply a chance result of the small number of cases involved—an explanation which appears to account for the irregularities of the later years. Possibly the peaks bear some relationship to the common assumption that unless a child has enjoyed vision for four or five years he will not have visual imagery in his later years. See Tóth (11) for an extended discussion of the imagery of those who lose their vision under five years of age.

Curves "i, j and k" present the results of a group of tests which correlate well with general intelligence and with ability to use English. They are presented here because it seemed likely from the theoretical point of view, that pupils with visual imagery *ought* to do better in the tests than those born blind. In the first test embossed sheets containing mutilated sentences are passed out, with instructions that the children should read the sentences, consider what words might be put in the blank spaces to complete the sense of each statement, and then write on their slates the words that should be supplied. There are ten sentences of increasing difficulty, the first one being, "We like good boys . . . girls," the last being "To . . . friends is always . . . the . . . it takes." Probably many of you on hearing these words, have a visual picture of the appearance of the words written or printed, and are able to supply the needed words by *seeing* them inserted. Of course all people do not carry on this simple thought process in visual terms, some using sound images, others the feeling of words in the throat, etc., but the visual method is most commonly reported by students of imagery, and we were inclined to expect that those without imagery would fail more frequently than the rest.

Much to our surprise, then, we discovered the same situation we have already reported for various other tests—those without visual imagery show an ability to handle this situation just about as well as any other group, and a large percentage of the high scores are credited to those who lost their vision in the first four years.

In the Verbal Ingenuity Test an embossed sheet was passed out upon which had been printed a series of sentences with the words in irregular order and one extra word introduced which interfered with the sense of the statement. For instance, the first sentence was printed "the cat at see" and the second "boy was sky the sick." The pupils were asked to read the sentences, to rearrange the words, silently, in their proper order, and to write upon their slates the extra word. As we anticipated, this test was more difficult for the blind than for the seeing, especially with the longer sentences at the end (the last one reads, "do not boy the I like who me school in sits desk behind"). The touch-reader, of course, is at a disadvantage because he must hold so many items in mind and cannot make a review of the sentence or a reference to some part of it as readily as the seeing child; so the time allowed the seeing was tripled for the blind to meet this difficulty. We also assumed that the lack of visual imagery would be a further handicap, but here as before, the curve based on age at loss of vision gave us a surprise—those who lost their vision in the early years test just about at average, and the general trend of the curve as a whole is *downward* rather than upward! Moreover, of those with a perfect score, fourteen belong to the early-blind group, and only four to the later group.

The Word Completion Test involves a similar mental process and the curves give similar results. Here a list of words is presented with various letters left out which the pupils are to supply, and then to write the word correctly. The blind children required a much increased time allowance and apparently had difficulty with many of the words because they could not spell them correctly! I have suggested that this test might be used as a spelling game (5, p. 21) using lists of words which the teacher wishes the children to learn, in place of our test words. The curve shows no special handicap because of early loss of vision, and the scatter diagram again gives a high percentage of the best scores to those who lost their vision early.

To return, then, to Mr. Allen's question, "Do your tests differentiate these classes—the congenital and the adventitious blind?" We have passed in review a series of curves and scatter diagrams formed to show the attainments in different school subjects and in various mental functions of nearly six hundred pupils arranged in groups according to the age at which their vision was lost. In every test the attainment of those who lost their vision in the early years measured up to the median attainment of the whole number tested, in most cases no upward trend is shown with increased years of visual experience, and in all the tests a considerable percentage of the highest scores were made by pupils of the early blind group. To be sure, we have not presented curves for all the different kinds of tests we have made, and there may be some test in which the lack of imagery will prove to be a determining handicap. We have presented, however, all the tests in which one would *expect* to discover the influence of a lack of imagery, and no such influence has been demonstrated. We certainly have no evidence to date that the congenitally blind have suffered in their educational and mental development because they have been taught in the same classes and by the same methods as the adventitious blind. Let us make the curriculum as rich and full as possible, and give the pupils the greatest possible chance to fill in during their school life the many and serious lacks in human experience which are a natural consequence of their blindness. But let us give our help in fullest measure to all, for those who have enjoyed vision during childhood seem as much in need as those born blind.

Upon the larger question raised in the introduction to this paper, the present study has no conclusive answer to make. The *mental constitution* of those born blind may well be essentially different from that of the other group, but the *functioning* of their minds as measured by our tests shows no such difference.

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IX

The Measurement of Educational Achievement in Schools for the Blind

This is an age of surveys and investigations. The millionaire purchasing a racing stable and the business man absorbing a factory unit are not satisfied with someone's assurance that they are getting a wonderful bargain, any more than the insurance company is willing to accept the owner's gross estimate of his loss by fire or water. All seek objective evidence—the testimony of scientific measurement—upon the values involved. A visitor from a foreign country who plans to establish a school for the blind may enjoy a trip through one of our institutions, but he will value most the actual figures showing capital investment, staff personnel, equipment, enrollment, and cost per pupil. Facts, rather than estimates, are equally valuable to the educational staff of the school itself. The principal teacher should know how his grades compare with similar grades in other schools for the blind and in schools for the seeing, and try to remedy the difficulty wherever he discovers a weak point. Teachers may determine by the use of objective tests the effect of new classroom methods or devices and locate individual pupils needing special attention. The pupils themselves may be motivated to renewed effort through progress charts in which their attainments are compared with objective norms.

It was the realization of these needs which prompted us early in our research program to publish a manual for the guidance of teachers of the blind in giving objective tests of general intelligence and of achievement in most of the regular school subjects. The limited issue of this manual was soon exhausted and later adaptations of tests covered only a few school subjects. It is now possible to make an up-to-date survey of most of the subjects taught in a school for the blind by means of the Stanford Achievement tests. These tests have a high reliability, since they have been standardized upon a large number of children in different parts of the country. They are provided in five equivalent forms so that the children can be measured in successive years without loss of accuracy.

A preliminary tryout by Dr. Kathryn E. Maxfield at Perkins Institution in 1933-34 with six of the ten tests—dictation, geography, language usage, literature, physiology and hygiene, history and civics—showed the value of this series of measurements. Acting upon the theory that the mechanism of reading test material by touch was an unfair handicap for the blind, all these tests were at first given orally. But this method made such extreme demands upon memory and was so time-consuming and fatiguing—some pupils even blistering their fingers with the long-continued writing—that Perkins Institution began putting the tests into braille and offering them for sale to other schools. During the school year (1935-36) the whole series of tests was given at Perkins Institution in the fall, and at the New York Institute for the Education of the Blind in the spring. On the basis of a very satisfactory experience with the tests, the following directions were prepared in collaboration with Mr. Francis M. Andrews at Perkins Institution, Mr. Harold Wright at the New York Institute, and Miss Ruth Sargent at the Pennsylvania Institution for the Instruction of the Blind, and the tests were given again the following year at Perkins Institution and at the New York Institute.

DIRECTIONS FOR GIVING THE NEW STANFORD ACHIEVEMENT TESTS (THIRD REVISION) ADAPTED FOR USE WITH THE BLIND

(Identical for all five forms. To be followed *verbatim*. It is strongly recommended that all testers *read* the parts printed in quotes to ensure uniform procedure.)

"Today we are starting a series of interesting tests which will give you a chance to show how much you have learned. I will now hand you each a copy of the first test pamphlet, but please do not look into it until I tell you to do so. Get out your braille slates, put in a paper, and write your name at the top of the sheet. Then please fold your hands and keep them folded until I give you the signal to start."

Place one pamphlet on each desk and say: "Now listen carefully and do just what I tell you to do. Do not begin until I say GO. The very second I stay STOP, you must stop work and hold up your stylus. After we have begun you *must not* ask any questions. If you drop your stylus, lose your place, or need more paper, raise your hand and I will help you. Do your best and do not pay any attention to what anyone else is doing."

Test I.A. Reading: Paragraph Meaning

"The first test contains a number of paragraphs, in each of which there is at least one word missing. Where these words should be you will find a line of dots. You are to read a paragraph through and decide what word may be needed to complete the meaning of the paragraph. Look at the beginning of the test and read the words at the top of the page." See that each pupil has the place. "It says (read slowly): 'Dick and Tom were playing ball in the field. Dick was throwing the ball and . . . . (pause) was trying to catch the ball.' Who was trying to catch the ball?" Encourage pupils to answer aloud. As soon as the correct answer is given, say: "Yes, Tom was trying to catch it. You must write Tom on the first line under your heading." Pause until the word is written.

"Wherever you see a line of dots it means a word has been left out. Begin with number 1, read each paragraph carefully, and write on your slates the *number* of the paragraph and *just one word* for each line of dots you come to in the paragraph. In each paragraph there is at least one word missing; some paragraphs have as many as three words missing. Do not write out the *whole paragraph*. Write *just one word* for each line of dots, arranging your answers across your paper, taking a new line for each paragraph. If you cannot think of the right word, or words, omit a line and go on to the next paragraph. When you have finished the first page of the test, go right on to the next and keep on working till I tell you to stop. Are there any questions? Begin with paragraph I. Ready, GO." Record the exact time of beginning the test. If the children ask permission to block out mistakes, allow them to do so. See that they do not stop with the first page. Try to keep all the pupils at work until time is called.

At the end of *thirty-five minutes* say: "STOP. I will now collect your papers."

Complete the test with *I.B.* the following day if possible, allowing another *thirty-five minutes*' working time. After sheets have been put in the slates, names recorded, and the pamphlets passed say: "This is another test like the one we used yesterday." It may be best to reread the paragraph above beginning "Wherever . . . ." Then say: "Ready, GO," and record the exact time of beginning the test. At the end of *thirty-five minutes* say: "All STOP," and collect the papers and pamphlets.

Test 2. Reading: Word Meaning

"Today we are to use another test to show how much you have learned. Please do not look into the test pamphlet until I tell you to do so. Keep your hands folded till I give you the signal to start work. For this test you will not need a slate, but will draw lines through certain words on the test pages with a pencil which I will give you." Pass pamphlets and pencils and then say: "In this test you will find a series of sentences, each of which needs one word to make it true, and following each sentence you will find a list of five words from which you are to select the correct one. When you have decided which of these five words will best finish a sentence, you are to draw a line through that word with your pencil. Before beginning the test we will try a couple of sample sentences to show you just what you are to do.

"Open your pamphlets to the page which starts with the sample sentence: 'A rose is a . . . . . . box flower home month river.' Of course a rose is a flower, so take your pencils and draw a single line through the word *flower*. Look at the next sentence. 'A roof is found on a . . . . . . book person rock house word.' Of course a roof is found on a house, so that is the correct word; draw a line through the word *house*.

"Now we are ready to begin the test. Do not start till I say GO, and the very second I say STOP, you must stop and fold your hands. After we have begun, you must not ask questions. If you drop your pencil, or lose your place, raise your hand and I will help you. If you come to some sentence you cannot do, skip it and go on to the next. Do your very best and do not pay any attention to what anyone else is doing. Remember that in this test you are to draw a line with your pencil through the word that makes a sentence true, just as in the samples we have worked over together. When you have finished with the first page go right on to the next. Do as many sentences as you can in the time given you. Are there any questions? . . . . Ready, GO."

Record the exact time of starting. At the end of *twenty-five minutes* say: "All STOP." Then collect the pamphlets, making sure that each child's name is on the outside of his pamphlet.

Test 3. Dictation Exercise

"Put your paper in your braille slate and write just what I tell you to write. (If pupils can use typewriters for this test, time will be saved in scoring their work.) On the first line put your name.

"The test today is a dictation test. I am going to read some words for you to write. Listen carefully and be sure to put down every word I read. Begin each sentence on a new line. The first sentence is . . . ." From the printed test sheet read the first sentence intended for the grade you are testing. Read the entire sentence each time. Do not break it up. A sentence may be reread once, or oftener, if necessary. If the children request the repetition of a sentence that has been passed, say: "Let that sentence go. Write this one." This may prevent many distracting requests for sentences done some time before. The tester should give all words clearly, in a natural voice, being careful not to confuse the pupils by unfamiliar pronunciations. If several teachers are to co-operate in giving this test, they should go over the words together and decide upon the pronunciations to be used, giving alternative pronunciations when the children do not seem to recognize a word. When the harder sentences are reached, it is well to encourage the children with such expressions as, "Do the very best you can, even if you are not able to write *all* the words." At no time are the pupils to be told that this is a spelling test.

Test 4. Language Usage

"Today we are to have a test to show how well you can use language. Please do not look into the test pamphlet until I tell you to do so. Keep your hands folded until I give you the signal to start. For this test you will not need a slate but will draw lines through certain words on the test pages with a pencil I will give you." Pass the pamphlets and the pencils and then say: "Turn to Test 4, and notice the sample sentence at the top of the page. It says: 'Apples is — are good.' " See that everyone has the right place. "Now which is the right word, is or are?" Encourage the pupils to reply. "Yes, the word *are* is correct. So take your pencil and draw a line through the word *are.*

"Read the next sample sentence. It says: 'He told — telled me.' Which is the right word, told or telled?" Pause for the answer. "Yes, so draw a line through the word *told.* Then fold your hands.

"There are several pages full of such sentences, with words in parentheses from which you are to choose. You must do as many as you can, starting when I give you the signal. You are to read each sentence carefully and draw a line through the word or phrase that makes the better sentence. If you come to a sentence you cannot do, skip it and go right on to the next. If you drop your pencil or lose your place, raise your hand and I will help you. After we have begun, you must not ask any questions. Are there any questions now? Ready, GO." Record the exact time of starting.

At the end of *twenty-five minutes* say: "All STOP." Then collect the pamphlets, making sure that each child's name is on the outside of his pamphlet.

Test 5. Literature

"Today we are to have a test to show how much you know about literature. Please do not look into the test pamphlet until I tell you to do so. Keep your hands folded until I give you the signal to start. For this test you will not need a slate, but will draw lines through certain words on the test pages with a pencil I will give you." Pass the pamphlets and the pencils and then say: "Turn to Test 5 and notice the sample sentence at the top of the page. It says: 'A giant is a big— dog man boat.' A giant is a big man, so take your pencil and draw a line through the word *man*. Look at the second sentence. It says: 'The Bible is the name of a— place country book.' *Book* is the word that makes the sentence true, so draw a line through the word *book*.

"There are several pages full of such sentences, with lists of words from which you are to choose. You must do as many as you can, starting when I give you the signal. You are to read each sentence carefully and draw a line through the word or phrase that makes the best sentence. If you come to a sentence you cannot do, skip it and go right on to the next. If you drop your pencil or lose your place, raise your hand and I will help you. After we have begun, you must not ask any questions. Are there any questions now? Ready, GO." Record the exact time of starting.

At the end of *twenty-five minutes* say: "All STOP." Then collect the pamphlets, making sure that each child's name is on the outside of his pamphlet.

Test 6. History and Civics

"Today we are to have a test to show how much you know about history and civics. Please do not look into the test pamphlet until I give you the signal to start. For this test you will not need a slate, but will draw lines through certain words on the test pages with a pencil I will give you." Pass the pamphlets and the pencils and then say: "This is another test like the one on literature. There are several pages full of sentences, with lists of words from which you are to choose. You are to read each sentence carefully and draw a line through the word or phrase that makes the best sentence. You must do as many as you can, starting when I give you the signal. If you come to a sentence you cannot do, skip it and go right on to the next. If you drop your pencil or lose your place, raise your hand and I will help you. After we have begun, you must not ask any questions. Are there any questions now? Ready, GO." Record the exact time of starting.

At the end of *twenty-five minutes* say: "All STOP." Then collect the pamphlets, making sure that each child's name is on the outside of his pamphlet.

Test 7. Geography

"Today we are to have a test to show how much you know about geography." Then read the directions exactly as given for Test 6, using the same time limit, *twenty-five minutes.*

Test 8. Physiology and Hygiene

"Today we are to have a test to show how much you know about physiology and hygiene." Then read the directions exactly as given for Test 6, using the same time limit, *twenty-five minutes.*

Test 9. Arithmetic Reasoning

"Today we are to have a test to show how well you can do problems in arithmetic. Please do not look into the test pamphlet until I tell you to do so. You will find a series of problems which you are to solve. You will write the *number* of the problem and the *answer* on your slates. You can easily do the first problems in your head, but you may begin using your arithmetic slates as soon as you like. On your braille slates use a new line for each problem, making two columns on the paper, one down the side, and one down the middle. (If pupils prefer they may use one column and have extra paper.) If you come to a problem you cannot do, write the number of the problem, leave a blank space, and go on to the next line. Does everyone understand?

"If you drop your stylus, lose your place, or need more paper, raise your hand and I will help you. Ready, GO." Record the exact time of starting.

At the end of *fifty minutes* say: "All STOP and fold your hands." Collect the pamphlets and the braille sheets, making sure that each child's name is written on both.

Test 10.A. Arithmetic Computation

"Today we are to have a test to show how well you can do examples in arithmetic. Please do not look into the test pamphlet until I tell you to do so. You will find a series of examples printed across the page with the number of each example before it in a parenthesis. On each example you will be informed what to do—whether to add, subtract, multiply, divide, etc. You can easily do the first examples in your head, but you may begin to use your arithmetic slates whenever you like. After solving an example write the number of the example and your answer on your braille slates, taking a new line for each example and arranging the answers in two columns on the paper, one down one side and one down the middle. (If pupils prefer they may use one column and have extra paper.) If you come to an example you cannot do, write the number of the example, leave a blank space and go on to the next line. Does everyone understand?" Allow time for questions.

"If you drop your stylus, lose your place, or need more paper, raise your hand and I will help you. Ready, GO." Record the exact time of starting. At the end of *forty minutes* say: "STOP, I will now collect your papers." Collect the pamphlets and the braille sheets, making sure that each child's name is written on both.

Complete the test the following day with *10.B.*, allowing *thirty-five minutes* of working time. At the end of that time say: "All STOP," and collect the papers and pamphlets.

Discussion and Interpretation

Comparison with the tests as published for use with the seeing will make evident the basic changes found necessary in adapting these tests for use with the blind: (1) greater detail in preliminary instructions and (2) an increase in time allowance to meet the three to one differential indicated by Caldwell's study[1] of an earlier form of these tests. For experts in testing, some of the details may seem unnecessary, but for teachers who only occasionally use objective tests, specific instructions, to be exactly followed, give the only assurance of standard procedure. The increase in time limits, while making it more likely that these tests will measure "power" rather than speed, as intended by their authors, produced certain difficulties which were most marked in Tests 1 and 10. As planned for the seeing, Test 1, requiring twenty-five minutes, and Test 2, requiring ten minutes, could both be given at one sitting, during an ordinary class period; and three further sittings were enough to complete the whole series of tests. Allowing three times as long for the blind would require twelve sittings for the whole series and more than a single class period apiece for Tests 1 and 10. As the items of each of these tests are arranged from easy to difficult we have divided each of these tests into parts A and B, printing the odd-numbered items in A and the even-numbered items in B, and for each part we have allowed approximately one-half of three times the seeing time allowance. The statistical basis for our time allowance in the whole series of tests may be found in Chapter XIII of this book.

The Stanford Achievement Tests show the same high reliability when given to the blind which is found when they are used with the seeing. At Perkins Institution, where all five forms of the test have been used in successive years, we have obtained the high reliability coefficients reported in Table I.

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[1] Floyd F. Caldwell, *A Comparison of Blind and Seeing Children in Certain Educational Abilities.* New York, American Foundation for the Blind, 1932, 28 pp.

Table I. Product Moment Correlations of Total Scores in Grades 4-9 from Successive Tests at Perkins Institution

Year	Form used	Year	Form used	Number	Cor.r	P.E.
1935	X	1936	Y	69	.93	.011
1936	Y	1937	Z	45	.96	.007
1937	Z	1938	V	43	.92	.016
1938	V	1939	W	49	.94	.012

Obviously in these tests we have an excellent instrument for measuring the effects of many educational factors such as changes in methods of teaching, the influence of different teachers, the relation of intelligence or amount of vision to school progress, etc. Moreover the test pamphlets serve as valuable review material, as they make it possible to give the children special training in their weak points. Since there are five forms of the tests there is little likelihood that any memory vestiges of a first trial will be left to affect the results when a form is used again five years later.

For administering these tests a school should obtain from the American Printing House for the Blind the items indicated in Table II.

Table II. Materials Needed for the New Stanford Achievement Tests, Forms V, W, X, Y, Z

Reprint of this article	On quota
Braille test pamphlets for form chosen Whole series of 10 tests or any single test (One pamphlet needed for each pupil tested)	" "
Specimen set of inkprint material for form chosen 1 inkprint copy of test 1 key for scoring 1 directions for administering 1 class record and analysis chart	At cost
Profile charts in packages of 25 or 50 (One chart needed for each pupil tested)	2c each or $1.40 per C

When preparing to give a test the teacher should be provided with a dependable watch indicating seconds so the timing may be accurate, a red pencil, and a copy of the test directions; for each pupil she should have one test pamphlet and one short black pencil. Golf pencils which may be bought in quantities already sharpened are excellent for the students to use.

After conducting a test the teacher should use the following keys for scoring the pupils' work: for Test 3, Dictation, the inkprint key may be used as it is; for Test 1, Paragraph Meaning, which has been divided into parts A and B, the odd-numbered A answers in the inkprint key should be underlined in red to make them stand out from the even-numbered answers used in B; for Test 10, Arithmetic Computation, which also has been divided into parts A and B, the odd-numbered A answers in the inkprint key should be underlined in red and the A and B answers then transferred to a sheet of paper on which they may be arranged in two columns (or one) to match the order of answers used by the pupils; for the other tests 2, 4, 5, 6, 7, and 8, braille keys should be made by encircling in red the correct answers as they appear in the braille test pamphlet, using the inkprint key as a guide.

When the papers have been corrected and the scores recorded these "raw scores" should be transmuted into "equated scores" by means of the tables at the bottoms of the pages in the inkprint test pamphlet. If only one part (A or B) has been used in tests 1 or 10, the "raw score" must be multiplied by two before transmuting it into an "equated score" of course. In tests 4, 5, 6, 7, and 8, minus scores are given the same equated score as a raw score of zero.

These equated scores have been so calculated that grade and age norms are the same for all the tests, i.e., a ten-year-old child should obtain a score of 50 on each of the ten tests, and a child beginning the seventh grade a score of 82 on each of the ten tests.

Next a profile chart should be made out for each child which will indicate his individual strengths and weaknesses in the different subjects and may be compared directly with the class marks his teacher has given him in the same subjects, and with his I.Q. From the same profile chart the teacher may read off the child's *educational age*, as indicated by his total score, and calculate his *educational quotient:* that is, the educational age divided by the actual age. This should be modified for the blind by subtracting at least two years from his actual age to balance the educational retardation due to blindness. *Subject quotients* may be similarly calculated for the eight separate subjects by dividing a child's subject age by his actual age less two years. His *accomplishment ratio* also may be calculated by dividing the child's educational quotient by his intelligence quotient, though there are serious questions concerning the validity of this ratio. A full discussion of all these points will be found in the inkprint directions for administering.

For the study of a grade, the pupils should be listed in order from highest to lowest in terms of total score upon the *class record sheet*, and then entered by number on the *class analysis chart*. This will show in graphic and easily comprehensible form, how the grade as a whole compares with the norms in each subject tested, and indicate in which subjects greater attention should be given to the grade as a whole or to particular students. Principal teachers will discover which teachers are especially successful with particular subjects, and may gain hints for a redistribution of classes according to the departmental system. A series of charts showing superior attainments in several grades will give just cause for congratulation; inferior results form a challenge to both teachers and principal. In a seventh grade tested, for example, we find superior attainment in language usage and geography (the class median being about two years above the norm), inferior attainment in physiology and hygiene and in arithmetic computation, and about normal attainment in the other tests. In I.Q. these pupils range from 130 to 94, with a single pupil at 69, the median I.Q. for the class being 112; in mental age they range from 18.6 to 12.11 with a single pupil at 11.1, the median of the class being 15.8. In chronological age they are only about one year older than seeing children of the seventh grade, so we have a class of considerable ability, and we should expect good work from them. The low scores in arithmetic computation are easily explained: not enough time was allowed, and they were asked to do, without arithmetic slates, a series of examples which the seeing would not be expected to do "in their heads." The low scores in physiology and hygiene would seem to indicate that not enough emphasis had been put upon these subjects. In the sixth grade of the same school, with somewhat lower median I.Q., we find language usage and arithmetic computation the low subjects. The latter is to be explained again by the nature of the test; the former must be studied further. The chart shows that six of the eight low scores come from pupils with I.Q.'s below 100, so the fault may not be entirely due to the teaching; but since these children practically all succeed better in the other tests, a change of emphasis and methods in the teaching of language usage may reasonably be expected to remedy the weakness. The use of the same tests in an alternative form this year may be expected to answer this question.

Interschool comparisons in spelling (dictation test) showed one school up to standard in the fourth, fifth, and sixth grades only, another school up to standard in the seventh, eighth, and ninth grades only, and a third school above the seeing standards in *all* the grades. Apparently it is not necessary for the blind to be poor spellers!

Illuminating subject analyses can be made through a comparison of individual results in any of the ten tests with the school marks given by teachers. As an example let us consider Table III, which shows a study of spelling ability in a fifth grade.

Column I gives the scores obtained in the Dictation Test by thirteen pupils to whom fictitious names are given in Column II. The average score is 50.6 and the median 51, the girls being considerably better than the boys. Column III gives the rank from best to poorest, an intermediate rank of 6½ being given to the two pupils who obtained the same score of 51. Column IV gives the school marks obtained in spelling, and Column V gives the rank in terms of school marks, A— being the highest, receiving a rank of 1, the two pupils with B+ receiving 2½, an intermediate rank between 2 and 3, etc. Column VI gives

Table III. Correlation of Scores in the Dictation Test, with Teachers' Marks in Spelling, in a Fifth Grade

I Test Scores	II Names	III Rank in test	IV Teacher's mark in spelling	V Rank in marks	VI Difference in ranks	VII Difference squared
77	Mary	1	A−	1	1	1
64	Jane	2	B	4½	2½	6.25
62	Clarissa	3	B+	2½	½	.25
58	John	4	B+	2½	1½	2.25
53	Helen	5	D	12	7	49
51	Elizabeth	6½	C−	9	2½	6.25
51	William	6½	B	4½	2	4
49	Ruth	8	C−	9	1	1
48	Carl	9	B−	6½	2½	6.25
40	Janice	10	C−	9	1	1
37	Robert	11	B−	6½	4½	20.25
36	Henry	12	D	12	0	—
32	Joseph	13	D	12	1	1
50.6	Average				Sum	98.50
51	Median					

$$\text{Correlation rho} = 1 - \frac{6 \times 98.50}{13\,(13^2-1)} = 1 - .27 = +.73$$

the numerical difference in ranks, regardless of sign, which is squared in Column VII. The sum of Column VII multiplied by 6 and used in the rank difference correlation formula,

$$\text{rho} = 1 - \frac{6 \text{ sum of } D^2}{n(n^2-1)} \text{ (where n = the number of pupils)}$$

gives a correlation of +.73, which would be considered a very satisfactory relationship. If Helen who tested fifth had not been marked so low in spelling by her teacher and if Robert who tested eleventh had not been marked so high, our correlation would have been much larger. In this school the correlations in spelling obtained by this method were as follows: fourth grade, +.78; fifth grade, +.73; sixth grade, +.85; seventh grade, +.71; eighth grade, +.44; ninth grade, +.75. In all but the eighth grade these correlations are so high that we must conclude that the single measurement of spelling by this half hour test in the Stanford Achievement series is about as reliable as the opinion of a teacher who has worked with a grade for half a year—these tests having been conducted in

February—and that we would be justified in recommending that the standard dictation test in one of its forms be given each year in place of any other final examination in spelling. Similar recommendations may be made for the other tests, if equally high correlations are discovered. The low correlation for spelling in grade eight was caused by wide variations in rank for six of the eighteen children tested; two of these were children of low I.Q. whom the teachers marked considerably lower than the ranks in their tests indicate that they are entitled to, while one other was a bright child whom the teacher ranked much higher than seems justified by the test—all illustrating a common type of error in judgment now attributed to the "halo of general merit."

Norms and Standards

After a careful study of tables and charts made from the results of the tests in Perkins Institution and the New York Institute, where two forms of the Stanford Achievement Tests have been used in succeeding years, it seems safe to propose that the printed norms for the seeing be used as standards for the blind in the first nine tests. This prediction has been justified through repeated use of the tests in these and in six other residential schools. Test 10 (Arithmetic Computation) introduces certain difficulties, and appears to demand abilities which we cannot reasonably expect from the average blind pupil, even when a liberal time allowance is granted. We recommend that in Test 10 the seeing norms for the next lower grade be used as the standards for each grade in schools for the blind.

The seeing norms may be found on the Educational Profile Chart. In the column headed School Grade, locate the number of the grade tested and take the corresponding number on the horizontal line to the left in the column headed Total Score. This will be the norm for all tests given in September; for tests given in later months go up the School Grade column one-tenth of a grade for each additional month: for instance, the norm for a sixth grade tested in September is 74, for October, 75, for December, 77, etc.

X

How to Handle Test Results—A Plea for the Wider Use of Group Tests

Many teachers of seeing children consider objective group tests the greatest contribution of modern educational psychology. Realizing the difficulty of making a fair appraisal of the written work of children whom they know very well and probably like or dislike as a result of daily association, they welcome a method by which they can measure accurately a large number of subject items and obtain numerical scores which indicate with some exactness the absolute and relative success of their pupils. Of course, standardized tests are preferred, as these give teachers a chance to compare their own pupils with those in other schools; but if a teacher composes her own tests and sets them aside, she soon has a collection which will serve in comparing succeeding classes. The enormous number of tests now published is an indication of the extent of this movement and constitutes a challenge to any teacher who has not tried objective tests.

It has occurred to the writer that teachers in schools for the blind may have hesitated to use objective group tests because of some uncertainty concerning the method of handling the test results and that a clear explanation of the procedure might induce more teachers to give such tests a trial. So he is here presenting the steps necessary for dealing with test results, taking as his data the scores obtained from a recent use of the Otis Classification Test, Part II, a short group test of general intelligence adapted for use with the blind by Miss Ruth Sargent at the Pennsylvania Institution for the Instruction of the Blind, Overbrook, Philadelphia, and reported in *The Teachers*

Forum, 1931, Vol. 4, No. 2, p. 30. The same procedure may be followed with any of the tests of school subjects presented by the writer in his *Self-Surveys in Schools for the Blind,* published at Overbrook in 1921, with the Stanford Achievement Test and the Gray Oral Reading Check Test, adapted for use with the blind by Miss Kathryn Maxfield and published by the American Foundation for the Blind in 1927, with the Monroe Standardized Silent Reading Test, adapted for use with the blind by Mrs. Margaret Owen Thomas at Perkins Institution and published in *The Teachers Forum,* 1929, Vol. II, No. 5, p. 6, and with any tests the teachers may themselves adapt from seeing models or may create from their own teaching materials. Of course, no comparison with norms will be possible with these original tests, until repeated or wide use shows what may be expected of blind children.

When first assembled the scores from the recent use of the Otis Classification Test in a third school were as follows:

TABLE I. RAW SCORES IN THE OTIS CLASSIFICATION TEST
PART II

Grade 6—10, 12, 26, 26, 23, 22, 30, 10, 21, 16
Grade 7—22, 27, 25, 17, 19, 28, 29, 13, 34, 26
Grade 8—28, 29, 37, 33, 31, 34, 31, 28, 22, 34
Grade 9—37, 29, 36, 35, 32, 22, 22, 25
Grade 10—37, 33, 35, 22, 38, 39, 37, 39, 40, 35, 37, 38, 36
Grade 11—36, 39, 31, 34, 32, 28, 25, 36
Grade 12—20, 29, 36, 38, 35

A casual inspection of this table indicates that while the scores tend to rise from grade to grade, there are some scores in each grade which are decidedly below the average for the grade, and that there is considerable overlapping of scores from grade to grade. But, knowing the great inequalities commonly found in grades of blind children, one naturally seeks some other basis of comparison and in this case the solution was suggested by Miss Sargent's article. When this test was used with 210 pupils in two large eastern schools, Miss Sargent found a rank order correlation of .586 with the I.Q.'s and a similar correlation of .755 with the mental ages obtained by the use of the

Irwin-Hayes adaptation of the Binet Intelligence Tests, and gave her norms in terms of mental age. Although both of these correlations are significant, we preferred to use mental ages as the basis for a study of the results, since the mental ages give an upward trend from year to year of chronological age and may be taken as the equivalent of grade groups in which pupils are assembled who have approximately the same abilities. Our first step then was to make a scatter diagram of these scores plotted according to the mental ages of the pupils tested, and across this diagram to draw a smoothed curve from Miss Sargent's norms. To smooth this curve we used the customary method of adding the scores from three adjoining mental age groups, dividing this by three, and substituting the new value for the original norm given by Miss Sargent. Ordinarily cross-section paper is used for such a scatter diagram.

Certain points at once emerge when this diagram is studied.

1. The pupils in this school show about the same ability as was found in two large schools where this test was standardized. The scores follow the same upward trend as the curve of norms, and there are about as many scores above as there are below the curve.

2. There is no conspicuous difference between the scores of the boys and those of the girls.

3. There is a small number of poor scores which need investigation.

If the reader will imagine two lines parallel to the line of norms, one line about five points above and the other about five points below the line of norms, he will find that the area so enclosed will include a large percentage of the scores, leaving only a small number below this central band, whose scores, therefore, require interpretation. We may assume that the scores in the enclosed band represent natural differences among individuals whose abilities do not vary widely, and that the very few with scores above this band are superior pupils whose test results show that they probably do not need special attention. A further study of the pupils whose scores appear below the central band shows that they can be treated as two rela-

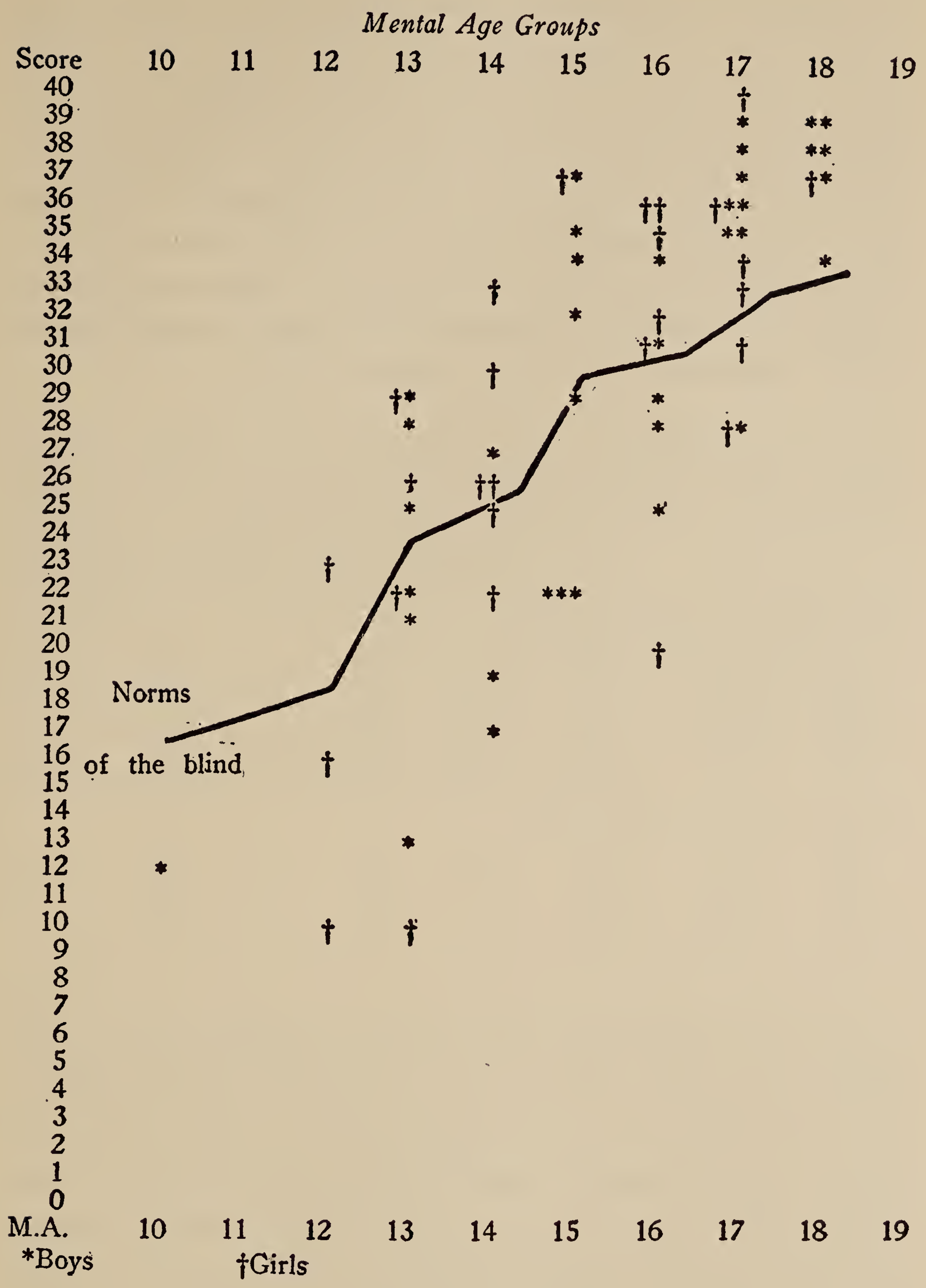

TABLE II. RESULTS OF THE OTIS CLASSIFICATION TEST, PART II, DISTRIBUTED ACCORDING TO MENTAL AGE

tively distinct groups, (a) those with fairly low I.Q.'s, whose scores in this test may be regarded as the natural result of low native ability, and (b) those of apparent ability who found this test particularly difficult. These points become plain in the following table, where we have presented the cases arranged in order from lowest to highest by I.Q., with the chronological age (C.A.), the mental age (M.A.), the Otis norm for each mental age, the score obtained in the test, and a coefficient of efficiency in this test, obtained by dividing the score obtained by the expected score for the same mental age.

TABLE III. ADDITIONAL INFORMATION CONCERNING PUPILS WHOSE SCORES WERE CONSIDERABLY BELOW THE NORMS FOR THEIR M.A.

	C.A.	M.A.	Otis Norm	Score in Otis test	Coefficient of efficiency i.e. score divided by norm
(a) Low I.Q.'s in Hayes Binet tests					
77	18.6	12.4	19	10	53%
83	18.4	13.5	24	13	54
85	20.0	13.7	24	10	42
89	16.0	14.3	25	19	76
93	20.3	14.11	25	17	68
94	21.8	15.1	30	22	73
(b) I.Q.'s Approximating average					
94	13.6	12.8	19	16	84
95	16.1	15.2	30	22	73
96	17.0	15.5	30	22	73
100	23.10	16.1	31	20	65
101	21.11	16.3	31	25	81

It will be noted that most of those in group (a) are older pupils whose added years of life and perhaps of school experience have not given them success in either the individual Binet tests or the Otis group tests. In group (b) one must study each case to see, for example, whether the small amount of braille used in this test put them at a disadvantage, whether the test aroused some emotional condition so that they did not do themselves justice, whether their physical condition on the day of the test was below normal, so that this acted as a distraction from the main business in hand. Then one might plan to repeat the test, or give an alternative form of it, at a later date, and compare the results of the two trials. It is commonly assumed that a group test may give an incorrect picture of a small number of the group tested, which will be corrected by repetition. Even then, there is a very great saving in time over that needed for individual tests, and such a large number of items can be covered that the teacher may determine which parts of her work have not been sufficiently emphasized.

In general the procedure in dealing with the scores obtained in group tests may be summarized as follows: First make a scatter diagram which will indicate the relationship of the individual scores and the group as a whole to the norms. Then study the exceptional scores, particularly the low ones to determine whether they have not been properly measured or really lack ability in the trait measured. From this study, methods of improvement may be planned for the hopeful cases, while the possibility of reclassification or regrading must be considered for the others. In case the group as a whole falls below the norms, the question naturally arises whether the methods of teaching, the arrangement of the curriculum, or the quality of the available student material is to be blamed. In any case science counsels us to face the facts.

XI

Can the Blind Pass in Geography?

THE SEEING readily admit that in so far as geography involves the learning of names of places and products, the blind might get along very well; and with the common assumption that their memories are above average, one might even expect them to excel in this phase of the subject. But what can they do with maps, which form so large a part of the geographical knowledge of the seeing person? How can they picture the location of the last war or the newest airplane route? And the psychologist, who knows about the tactual maps used in schools for the blind, wonders how maps of a different size can be of any use. He has learned how it feels to stretch an octave, for instance, on the piano, and wonders how he could play octaves on a piano that has keys only half as wide. This question was raised in our first use of a map test; see Chapter II.

Teachers of the blind know very well that their pupils can pass in geography and they will heartily welcome as an aid in educating the seeing public, Miss Clara L. Pratt's recent pamphlet on *Practical Geography For the Blind*, which gives pictures of the numerous devices planned to aid the blind in learning geography through the fingers, from the hundred-year-old globe of the world thirteen feet in circumference made of seven hundred pieces of wood, which has always caught the eye of visitors entering Perkins Institution, to the braille maps, wall maps, puzzle maps, globes, season apparatus, plasticine maps made by the students themselves, and finally the wonderful sets of 350 geographical, historical and sectional maps produced as a Work Projects Administration project.

Just how successful this teaching might be, was one of the questions raised in the survey of ten schools for the blind in the early years of our research, and two standard tests of geography were included in our series, the Hahn-Lackey test of geographical information and the Courtis map test of states and cities in the United States of America. In general we found the blind testing about up to the seeing standards in the information test, but decidedly below the seeing in the map tests.

HAHN-LACKEY STANDARD TEST OF GEOGRAPHICAL INFORMATION

Object.—The purpose of this test is to determine the extent of the pupils' information in geography, and their ability to use their knowledge in simple problems. The authors list five specific uses for the test: (1) to measure the individual pupil's ability as an aid to classification or promotion; (2) to measure a class as a whole by comparison with an outside standard; (3) to measure the results of a year's work in geography; (4) to measure the balance between the different phases of geography work (by studying the nature of the exercises missed by her pupils the teacher may discover which phases of the work should receive more attention); and (5) to measure the merit of different methods of instruction such as map drawing, laboratory exercises, field work, problem assignments, and departmental teaching.

Material.—Ten 66 per cent questions from the Hahn-Lackey (13) Geography Scale for each grade. This scale is based upon 283,100 answers by 1,696 pupils in twelve schools for the seeing, and constructed in much the same way as the Ayres spelling scale. We have selected five memory questions and five thought questions for each grade list. Copies of the whole scale may be purchased from H. H. Hahn, Wayne State Normal School, Wayne, Neb., at seven cents each.

Fourth Grade

1. Name four things out of which clothing is made.
2. Give two ways in which food, clothing, lumber and coal are brought to us.

3. Name four continents.
4. Name two necessary things that we get from the sun.
5. Name four races of men.

6. Give one way in which farming may be done in dry countries.
7. Give two ways in which rivers are useful.
8. Why should roads or streets be higher in the middle than on the sides?
9. Where do plants get water?
10. What makes clouds move?

Fifth Grade

1. Name the five great lakes of North America.
2. What are the two largest cities of the United States?
3. Name two ways in which the farmer helps to get food for us.
4. Give two ways in which water gets away when it rains.
5. What is the name of the circle extending around the earth midway between the poles?

6. Why does not the water flow out of swampy places?
7. Why do not the Eskimos build houses like ours?
8. What is under the ocean?
9. Where does the water in a well come from?
10. Name two ways in which winds are useful.

Sixth Grade

1. Name four fur-bearing animals.
2. Name four large rivers of Europe.
3. Name two kinds of food that we get from animals.
4. From what country do we get much of our coffee?
5. Which is the largest and which is the smallest—the moon, the sun or the earth?

6. What country of South America has a climate similar to ours?
7. Why is it warmer in New Orleans than in Chicago?
8. Why are camels such useful animals for traveling in desert places?
9. What is the cause of day and night?
10. What do the rivers do with the soil that they carry?

Seventh and Eighth Grades

1. How are valleys made?
2. Name two important crops raised in southern United States and tell why they are grown there.
3. Name a mountain range and a river between Europe and Asia.
4. What direction is Australia from Asia, and to whom does it belong?
5. Name a large lake entirely in the United States.

6. Why would you not expect Russia to have as many sailors as England?
7. Why are the great plains just east of the Rocky Mountains not good for farming?
8. A doctor advises a patient to go to a region of light air and warm climate. Where would he go?
9. What good may leaves do after they fall from the trees in the autumn?
10. In what part of Australia are most of the people found?

Method.—Pass around blank sheets of paper and have pupils write name, age, grade, and the date at the top. Then say:

"I am now going to give you a test in geography. I will read to you ten questions, one at a time. After I have read a question, I will give you a reasonable time to write the answer. Do not write the *question;* write only the *number* of the question, and your *answer* to it. Are there any questions?"

Give further information as needed and then say, "Ready," and read the first question through slowly, twice, that everyone may be sure what it is. Then allow two, three, or even more minutes for the answer, as needed. Watch the pupils, and wait till most of them have finished. Then say, "Question 2 is this," and read it. Thirty to forty minutes should be enough for the test.

Scoring.—Compare the pupils' answers with the following key, allowing full, half or no credit as indicated below. Multiply the total credits by 10 to change the score to per cent right. Many of the questions admit of only one answer, but the scale contains some questions to which the answers may vary.

In order that the scoring of the answers by teachers of different localities may be uniform and the scores comparable with those of the scale, the authors suggest the following typical answers:

Key for Scoring the Hahn-Lackey Geography Test

Fourth Grade Questions

1. Leather, wool, silk, cotton, fur, paper, etc.
2. Any two: by railroad, wagon, mail, ships.
3. North America, South America, Africa, Eurasia, Australia, Europe, Asia.
4. Heat, light.
5. Caucasian or White; Indian or Red; Mongolian or Yellow; Ethiopian, Negro, or Black; Malay or Brown.

6. Irrigation.
7. Any two: fish, navigation, sport, waterpower, drains the land.
8. For drainage, so road won't be washed out, etc.
9. From the earth, from the air, from rain, from springs.
10. Winds, breezes, air, atmosphere.

Fifth Grade Questions

1. Superior, Michigan, Huron, Erie, Ontario.
2. New York, Chicago.
3. Any two lines of work: Plants grain and harvests it; raising cattle and farming; raises crops and milks; farming and selling things. (Allow half credit for only one line of work.)
4. Evaporation, absorption, runs away.
5. Equator.

6. Because they are low, because they have no outlet.
7. They have no wood, can't make bricks.
8. Earth, land, rock, stone, mountains, sand, plain, plateaus. (Any answer indicating a knowledge of the bed of the ocean.)
9. Out of the ground, from veins, springs, from little streams under the ground, from moisture in the ground. (Any answer clearly implying underground source.)
10. Any two: Bring rain, turn mills, fresh air, makes temperature equal, makes pressure equal, scatters seeds, causes ocean currents.

Sixth Grade Questions

1. Any hairy animal.
2. Danube, Rhine, Rhone, Thames, Elbe, Oder, Vistula, Dnieper, Don, Volga, Dwina, Seine, Loire, Tiber, and others.
3. Different kinds of meat are credited as only one kind of food.
4. Brazil, South America, Mexico and Central America.
5. Sun, moon.

6. Chile, Argentina, Uruguay, Paraguay.
7. Rays fall more nearly vertically, farther south, nearer the equator. (Give no credit for ocean breezes, gulf stream.)
8. Capacity for water, can go a long time without drink.
9. Turning, revolution, or revolving of earth on axis.
10. Let it down in the valleys or sea, leave it on the bank, form islands, drop it at the mouth, drop it when the current is not swift. (Any answer that indicates that rivers take soil from one place and put it in another place.)

Seventh and Eighth Grades

1. Streams. (Give half credit for glaciers, folding of crust.)
2. For first part, any two of the following: cotton, rice, sugar cane, fruit, corn, garden truck. For second part: Long warm growing season with plenty of rain.
3. Ural Mountains and Ural River.
4. Southeast, and belongs to England.
5. Lake Michigan, Salt Lake.

6. Has few seaports, coast frozen up most of year.
7. No rain, no water, no rivers.
8. High parts of southern United States or Europe, etc.
9. Mulch, soil, enrich soil.
10. Around the coast, southeastern coast, northern coast, etc.

Interpretation.—If a single grade is tested, the teacher will be interested in making a scatter diagram of the pupils' scores, and tracing across it a curve based on the standard scores for the blind in Table I. If a whole school is tested, a series of scatter diagrams and curves is suggested, based on chronological age, mental age, intelligence quotient and grade. We have no standards by mental age and I. Q. but some interesting points might emerge from the diagrams. For the curve by grades use the seeing standard of 66 per cent. (This being a graded test each successively higher grade is expected to get 66 per cent correct with more difficult material.) In all these scatter diagrams the vertical column at the left should show per cents, and the horizontal line at the bottom the C. A., M. A., I. Q. or grade. A sample scatter diagram may be found on page 5 of my *Self-Surveys in Schools for the Blind.*

TABLE I. RESULTS OBTAINED IN EIGHT SCHOOLS FOR THE BLIND WITH THE HAHN-LACKEY TEST OF GEOGRAPHICAL INFORMATION

Ages	Number of pupils tested	Median scores in per cent correct	Standards for the blind
10	5	73	71
11	19	68	70
12	39	68	68
13	32	68	68
14	53	68	66
15	65	63	65
16	68	63	63
17	73	63	61
18	53	58	61
19	32	63	60
20	66	58	60
Total	505		

In each grade list the first five questions are memory questions while the second five are thought questions. Teachers will naturally consider which group makes more trouble for their pupils, and why. Also by the use of the author's complete scale other sets of questions may be formed, for use at different times during the year, items being selected of equal, greater or less difficulty as indicated in the scale.

THE COURTIS MAP TEST

Object.—The aim of this test is to determine how clear an idea the pupils have of the location of the states of the Union on a map which is probably of a different size from the one used in their class work.

Material.—Paper map of the United States, embossed on a sheet 20 by 16 inches, 150 miles to an inch, which may be obtained through the American Printing House for the Blind. The boundary lines of the states, the water of the Pacific Ocean, the Atlantic Ocean, the Gulf of Mexico, and the Great Lakes are indicated in the customary ways. In each state except the smallest, one or two cities are indicated by large dots and a number printed without the number sign.

Method.—Pass around blank sheets of paper and ask the pupils to write name, age, grade, and the date at the top of the sheet. Then pass one map to each pupil and give the following instructions:

"I want to see how well you can locate the different states on this paper map of the whole United States. Please examine the maps. You will notice that only the coast lines, state boundaries, and a few cities are indicated. Near the middle of each state you will find a number, without the number sign. I am going to ask you to find various states on the map, one at a time as I read the names. When I name a state, you will please find it on the map, read the number printed in it, and then write the number and the name of the state on your slates."

Allow about thirty seconds for examination of the map and then say:

"I will illustrate with the state in which your school is located. All find. . . . . .on the map. What is its number? . . . . Yes. Now please write this number and the name of the state on your slates. You may use contractions or abbreviations in writing the names. I will give the customary abbreviations as I go along.

"Now we are ready for the test. I will read the name of a state; you will find the state on the map, read its number silently and then write its number and name on your papers. You may put several answers on each line. Do not try to go back and change any answers. Does everyone understand?"

Answer questions about procedure and then read the states in the following order, omitting the home state used as an example. Use the form of words indicated below. Allow forty-five to sixty seconds for the pupils to find each state and to write the number and name.

List of States to Be Located

"California: Write the number and then C-a-l."
"Maine: Write the number and then M-e."

Texas, Tex.
Georgia, Ga.
Michigan, Mich.
Ohio, O.
Rhode Island, R. I.
Virginia, Va.
Wisconsin, Wis.
Louisiana, La.
Minnesota, Minn.
South Carolina, S. C.
Indiana, Ind.
Nebraska, Neb.
South Dakota, S. D.
Utah, Utah
New Mexico, N. M.
Arkansas, Ark.
Florida, Fla.
Washington, Wash.
Montana, Mont.
Maryland, Md.
Massachusetts, Mass.
Oregon, Ore.
Kentucky, Ky.
New Jersey, N. J.
Vermont, Vt.
Colorado, Colo.
West Virginia, W. Va.
North Carolina, N. C.
Mississippi, Miss.
Idaho, Idaho
Arizona, Ariz.
Pennsylvania, Pa.
Tennessee, Tenn.
North Dakota, N. D.
Connecticut, Conn.
New York, N. Y.
Illinois, Ill.
New Hampshire, N. H.
Missouri, Mo.
Delaware, Del.
Kansas, Kan.
Iowa, Ia.
Alabama, Ala.
Wyoming, Wy.
Oklahoma, Ok.
Nevada, Nev.

When all have finished the test with the states, say:

"Now I want to make a similar study of cities. Find . . . . on the map (naming the capital of the state in which the school is located). What is the number of the state in which . . . . is located? Yes. Now write the number of the state and the name of this city on your papers. You need not write the *name* of the state; just the number of the state and the name of the city. You may use contractions or abbreviations as before. I will suggest abbreviations. Write several answers on a line. Do not try to go back and correct answers, as time will not be allowed for this. Does everyone understand just what is to be done?"

Answer questions about procedure and then read the cities in the following order and by the formula suggested, allowing about thirty seconds for each city.

List of Cities to Be Located

"Chicago: Write the number of the state in which Chicago is located and the abbreviation, C-h-i.

San Francisco: Write the number of the state in which San Francisco is located and then the abbreviation, S-a-n-F.

Buffalo, Buff.
Pittsburgh, Pitts.
Savannah, Sav.
Galveston, Gal.
Omaha, Om.
New York, N. Y.
Cleveland, Clev.
Louisville, Louis.
Salt Lake City, S. L.
Richmond, Rich.
New Orleans, N. O.
Detroit, Det.
Philadelphia, Phil.
St. Paul, St. P.
St. Louis, St. L.
Kansas City, Kan.
Baltimore, Balt.
Denver, Den.
Rochester, Roch.
Duluth, Dul.
Portland, Port.
Seattle, Sea.
Boston, Bost.
Milwaukee, Mil.
Los Angeles, Los A.
Indianapolis, Ind.
Cincinnati, Cin.
Memphis, Mem.

Scoring.—Score the pupils' papers with the aid of the following key, counting one for each correct answer. There are forty-eight states and thirty cities in the lists, but from these numbers the home state and home city must be deducted.

Key to the Braille Map of States

Cal.	Me.	Tex.	Fla.	Pa.	Ga.	Wash.	Tenn.	Mich.
41	13	21	46	28	31	14	42	12
Mont.	N. D.	Ohio	Md.	Conn.	R. I.	Mass.	N. Y.	Va.
22	17	23	9	8	1	3	32	48
Ore	Ill.	Wis.	Ky.	N. H.	La.	N. J.	Mo.	Minn.
18	27	24	38	6	11	5	15	44
Vt.	Del.	S. C.	Colo.	Kan.	Ind.	W. Va.	Iowa	Neb.
7	2	36	26	19	34	4	40	10

N. C.	Ala.	S. D.	Miss.	Wy.	Utah	Idaho	Ok.	N. M.
39	43	33	25	29	47	16	35	37
Ariz.	Nev.	Ark.						
30	20	45						

Key to the Braille Map of Cities

Chi.	San F.	Buff.	N. O.	Dul.	Pitts.	Det.	Port.
27	41	32	11	44	28	12	18, 13
Sav.	Phil.	Sea.	Gal.	St. P.	Bost.	Om.	St. L.
31	28	14	21	44	3	10	15
Mil.	N. Y.	Kan.	Los A.	Clev.	Balt.	Ind.	Louis.
24	32	15	41	23	9	34	38
Den.	Cin.	S. L.	Roch.	Mem.	Rich.		
26	23	47	32	42	48		

Interpretation.—If a single grade is tested, the teacher may be interested in making scatter diagrams of the pupils' scores in the tests of states and cities, and tracing across the first diagram a curve based on the scores for the blind presented in Table II. We have no norms for the test with cities. If a whole school is tested, a series of scatter diagrams and curves is suggested, based on chronological age, age at loss of vision, mental age, intelligence quotient, grade, number of years in school, and number of years maps have been used.

TABLE II. RESULTS OBTAINED IN EIGHT SCHOOLS FOR THE BLIND WITH THE COURTIS MAP TEST OF STATES
(HIGHEST POSSIBLE SCORE, 48)

Ages	Number of pupils tested	Median scores	Standards for the blind
10	4	2	3
11	13	5	6
12	21	11	10
13	25	13	14
14	38	19	17
15	39	20	22
16	54	27	26
17	62	31	26
18	40	20	23
19	33	17	21
20	49	25	23
Total	378		

The scores obtained from the use of these map tests were the most scattered and the curves the most irregular of all the data collected in the survey. The results showed little relation to age, grade, or age at loss of vision. In fact thirty-nine of the fifty-five pupils who scored above 30 lost their vision under five years of age and those born blind, who comprised about one half of those tested, scored equal to the other half. Inquiry disclosed great differences in the use of maps in various schools and grades and this probably explains the wide variation in scores. On the other hand, the high scores occasionally found with pupils blind from birth demonstrate the possibilities of accomplishment when map work is seriously taught. It seems highly desirable that such a test should now be widely used to determine whether our improved methods and aids have produced the results desired. In our survey the curves by age and grade for 378 blind children did not equal a curve based upon one half the standards for the seeing, though occasional blind children with practically no vision made scores quite up to the seeing standards.

THE NEW STANFORD ACHIEVEMENT TEST, NO. 7, GEOGRAPHY

Object.—The purpose of this test is to measure the pupils' knowledge of geography and their ability to use it in an objective test of the multiple-choice completion type.

Materials.—From the American Printing House for the Blind, order one inkprint copy of each of the following—the directions for administering, the key and directions for scoring, and an advanced examination pamphlet for grades four to nine in one of the five forms V, W, X, Y or Z; and secure enough braille pamphlets of the *same form* to provide one copy for each pupil. Each form of the test consists of eighty incomplete sentences, each sentence being followed by three words, one of which will satisfactorily complete the sentence, as follows:

1. Wool comes from the
    cow hog sheep

2. The earth is shaped most like a
   baseball football pear
3. An important orange-growing state is
   Vermont California Missouri
4. The month before April is
   March May June
5. The largest city of the United States is
   Chicago New York Washington

The sentences are listed in order of difficulty, the easiest appearing at the beginning and the most difficult at the end of the test. These sample sentences have been taken from Form Y. Since there are five equally difficult forms of the test, it is possible to test pupils at the beginning and the middle or end of the year, and in succeeding years, to show progress, without the danger that memory of a former test might vitiate the results of a later one. Norms are established for years and months of age, and for grades and tenths of a grade, so it is possible to check results against standards at any month in the school year. Used test sheets also make very good review material.

Method.—Say: "Today we are to have a test to show how much you know about geography. Please do not look into the test pamphlet until I tell you to do so. Keep your hands folded until I give you the signal to start. For this test you will not need a slate, but will draw lines through certain words on the test pages with a pencil I will give you." Pass the pamphlets and the pencils and then say: "Notice the first sentence at the beginning of the pamphlet. It says: 'Wool comes from the—cow hog sheep.' Now, of course wool comes from *sheep,* so take your pencil and draw a line through the word *sheep.* Look at the second sentence. It says: 'The earth is shaped like a—baseball football pear.' The word *baseball* makes the truest sentence, so draw a line through *baseball.*

"There are several pages full of such sentences, with lists of words from which you are to choose. You must do as many as you can, starting when I give the signal. You are to read each sentence carefully and draw a line through the word or phrase that makes the best sentence. If you come to a sentence you cannot do, skip it and go right on to the next. If you drop your pencil or lose your place, raise your hand and I will help you. After we have begun, you must not ask any questions. Are there any questions now? Ready, GO." Record the exact time of starting.

At the end of *twenty-five minutes* say: "All STOP." Then collect the pamphlets, making sure that each child's name is on the outside of his pamphlet.

Scoring.—Use the printed key to correct the pupils' work and on their pamphlets, under their names, record the scores. Then transmute these raw scores into equated scores by means of the tables at the bottom of the inkprint test pamphlet of the same form as that in braille, and use these equated scores in the further calculations.

Interpretation.—As we have rather complete norms for this test, teachers will be interested in making a number of scatter diagrams, by chronological age, by mental age, and by grade, and perhaps also by I. Q., by classroom mark in geography, by age at loss of vision, by number of years in school, by reading rate, etc. When arranged by C. A. the curves for one school were fairly regular at the two testing dates and practically equal to the seeing norms for ages nine to fifteen inclusive, but after the age of fifteen attainment dropped rather suddenly; in the other school the curves for both years were quite irregular and showed no clear upward trend from year to year. Teachers may wish to make C. A. curves to see if they obtain similar results, using the seeing standards in the column marked "educational age" in the Educational Profile Chart to be found on page 2 of the inkprint test pamphlet; but it is recommended that the results be graphed by *mental* age instead. In Table III, we are presenting our results for the first test in two schools arranged by M. A. Considering the small number of cases in each age group in a single school, it is not surprising that the average scores and the per cent of the norms should vary from year to year; but when the two schools are combined we find a pretty regular increase of average score with each year of mental age and such a close approximation to the printed norms for the seeing, that we feel justified in recommending that the seeing norms by C. A. be used with tables of results for the blind assembled by M. A.

TABLE III. STANFORD ACHIEVEMENT TEST, NO. 7, GEOGRAPHY, RESULTS IN TWO SCHOOLS FOR THE BLIND ARRANGED BY MENTAL AGE

	School A, Tested in Nov. '35				School B, Tested in Feb. '36				Two schools combined			
M.A.	No. tested	Av. score	Norms for Nov.	Per cent of norm	No. tested	Av. score	Norms for Feb.	Per cent of norm	No. tested	Av. score	Norms for Dec.	Per cent of norm
19	1	112	119	94	4	121	121	100	5	119	120	99
18	6	105	116	91	8	101	117	86	14	102	116	88
17	9	110	111	99	8	108	113	95	17	109	112	97
16	15	94	104	90	15	96	106	91	30	95	105	90
15	9	89	97	92	7	103	99	104	16	96	97	99
14	18	83	92	90	9	101	93	109	27	88	92	95
13	7	81	86	94	5	93	87	107	12	86	86	100
12	6	67	77	87	6	71	79	90	12	69	78	88
11	16	59	66	90	4	58	69	84	20	58	67	87
10	9	48	53	91	4	57	56	101	13	51	54	94
9	6	38	39	97	5	55	43	128	11	46	40	115
Totals	102				75				177			

When arranging results by grade, teachers may use the seeing standards presented in the column marked "school grade" in the Educational Profile Chart; they should then compare their results with Table IV, which gives the average scores by grades in the two schools tested in 1935-6. It will again be observed that when the two schools are combined to give larger numbers in each grade, the average scores compared very favorably with the norms for the seeing. The difference in attainment in the two schools is to be explained largely in terms of the difference in maturity of the two sets of pupils; School A having an average C. A. of 12:10 years, an average M. A. of 13:6 years, and an average I. Q. of 106; while School B had an average C. A. of 14 years, an average M. A. of 14:10 years, and an average I. Q. of 109:6.

TABLE IV. STANFORD ACHIEVEMENT TEST, NO. 7, GEOGRAPHY, RESULTS IN TWO SCHOOLS FOR THE BLIND ARRANGED BY GRADES

	School A, Tested in Nov. '35				School B, Tested in Feb. '36				Two schools combined			
Grade	No. tested	Av. score	Norms for Nov.	Per cent of norm	No. tested	Av. score	Norms for Feb.	Per cent of norm	No. tested	Av. score	Norms for Dec.	Per cent of norm
9	22	101	97	104	9	102	99	103	31	102	98	104
8	18	87	91	95	19	107	93	115	37	97	92	105
7	16	93	84	111	17	103	86	119	33	98	85	115
6	17	76	76	100	12	100	78	128	29	86	77	112
5	13	59	65	91	11	75	68	110	24	66	66	100
4	16	43	52	83	12	61	57	107	28	50	53	94
Totals	102				80				182			

Many interesting questions may be answered through the study of data collected by the use of the Stanford Achievement Tests. The writer has made a number of calculations from the results within single grades, using the simple correlation method described in his previous article. Table V gives the resulting coefficients of correlation in a low and in a high grade in each school.

TABLE V. CORRELATION COEFFICIENTS BY THE RANK ORDER METHOD IN TWO SCHOOLS FOR THE BLIND

	School A		School B	
	Grade 4	Grade 7	Grade 4	Grade 7
Geography scores in '35-6 and in '36-7	+.79	+.77	+.71	+.86
Geography and Reading 1, '35-6	+.59	+.37	+.44	+.42
Geography and Reading 2, '35-6	+.68	+.42	+.44	+.30
Geography scores and I. Q., '35-6	+.49	+.68	+.80	+.64
Geography scores and Teachers' marks, '35-6	+.62	+.36		
Spelling scores and Teachers' marks, '35-6	+.78	+.71		

It will be remembered that in this method of calculating correlation the scores are ranked from highest to lowest in each of the two measurements compared and the differences in rank used to determine the amount of correlation, which may range from +1.00 to —1.00. In the first line of Table V we find correlations ranging from +.71 to +.86, which indicate that in the grades examined the pupils maintained much the same rank when retested, those testing high at first tending to be towards the top on the second test, while those who were low on the first test tended to be low on the second. Had the exact order been maintained, we should have found a correlation of +1.00. These correlations compare favorably with the seeing coefficients of reliability (+.51 for the fourth grade and +.82 for the seventh grade) and indicate that this test in its various forms is a fairly dependable one. As there are five alternative forms, provision is made for an annual check-up through as many years as geography is commonly taught.

The next two sets of correlations were calculated to see whether one might say that facility in reading would affect the scores in geography, since this test was given tactually. The correlations are all positive and are high enough to show the influence of differences in reading without being so high as to suggest that the reading tests alone would be sufficient without the test in geography. It will be noted that this dependence is most marked in the fourth grade. The first reading test shows the ability of the children to grasp the meaning of paragraphs and use their information in completing sentences based on the reading. The second test is a measure of word meaning, a short statement being given which may be completed by one of four words printed after it. This test is in the same form as the geography test. The correlations show no decided differences between facility in reading as tested by either method, and scores in geography.

Additional correlations were calculated by the Pearson Product Moment Method for all the pupils tested in two schools and are presented in Table VI.

It will be observed that when the scores in geography are compared with the average of the two reading scores, correlations of +.81 and +.80 were obtained. Of course one would

TABLE VI. CORRELATION COEFFICIENTS BY THE PEARSON PRODUCT MOMENT METHOD IN TWO SCHOOLS FOR THE BLIND IN 1935-6

	School A		School B	
	No. of Cases	Cor.r	No. of Cases	Cor.r
Geography 7 and average of Reading 1 and 2	100	+.81	78	+.80
Geography 7 and Literature 5	100	+.79		
Geography 7 and Physiology and Hygiene 8	103	+.79	75	+.77
Mental Age and total score in Stanford Achievement Tests			76	+.75

expect to get higher correlations with the larger numbers involved here, as compared with single grades in Table V, but the high correlations with test 5, literature, and with test 8, physiology and hygiene, both of which are printed in the same form as the geography test and so depend largely upon tactual reading, support our earlier emphasis upon the need of fair reading facility to succeed in this geography test.

Another factor of importance is indicated by the relatively high correlations of geography with I. Q. in Table V, and the correlation of +.75 in Table VI when mental age is compared with total score in School B, supporting our earlier position that mental age rather than chronological age should be used in curves, since intelligence is so important in all school work.

The comparison of scores in geography and teachers' estimates of class work in that subject presented in Table V gives correlations which are somewhat lower than similar correlations in spelling, but, in general, the ranks in the test support the judgment of the teachers.

Individual students may be studied by the calculation of Geography Quotients and Geography Accomplishment Ratios. The Geography Quotients of children of average I. Q. may be obtained by reading off from the Profile Chart the educational age corresponding to the pupil's equated score, and dividing this by his chronological age; the Geography Accomplishment Ratio, which seems still more valuable, may be obtained by dividing his educational age in geography by his mental age. The Geography Quotient will show whether the pupil is doing as well as a normal child of his age should be expected to do; the Accomplishment Ratio will indicate whether he is making proper use of his abilities. Teachers will also wish to seek explanations for any marked discrepancies between the scores pupils achieve on this standard test and the teachers' marks for daily work, which are brought prominently to our attention through the use of the rank order correlation method. Such discrepancies are sometimes caused by deficiency of memory which prevents pupils from retaining over any considerable period what they learn in daily recitation, but more often by the fact that the teacher has rated the quality of daily work too high or too low. Excessive shyness, faults of personality, and evident lack of industry are cited as common reasons for unjustly low marks by teachers of the seeing, while exceptionally attractive personality, exemplary conduct and studiousness tend to produce lenient marking.

Our study of the scores of individuals discovered a considerable number of very superior records, 4 per cent in School A and 19 per cent in School B scoring in the first test at least two years above the norms for their mental age. A somewhat larger number of pupils (16 per cent in School A and 20 per cent in School B) tested two or more years below their mental age norms. Many of those getting low scores in the first test showed distinctly higher scores in the second test about one year later, indicating the possibility of improvement through special instruction motivated by standard tests.

SUMMARY

Three standard tests in geography with norms for interpretation have been presented, and also, an extended study of the results of the geography test in the Stanford Achievement series. In general, the author would recommend that testing be begun with the use of the last which is an up to date and well-constructed test. But both the other tests are well worth occasional use, partly to check up the results of the Stanford Achievement Test, and partly to get the advantage of a different method of testing information and its use as provided for in the Hahn-Lackey test, and to measure progress in the use of maps by means of the Courtis test. Mention should also be made of another excellent test in geography which has been standardized upon a very large number of seeing pupils, a considerable part of which could be adapted for use with the blind, the Wiedefeld-Walther Geography Test published by the World Book Company. This test recognizes the importance of reading by placing first a test of ability to understand and use passages of geographical information. Test 2, "Organization," seeks to measure the pupils' ability to give causes and reasons for geographical phenomena. Test 3 measures ability to read maps and graphs and could be used with the blind only in greatly modified form, if at all. Test 4, "Geography Vocabulary," and test 5, "Geographical Relationships," could easily be adapted for the use of the blind. Test 6, "Place Geography," reminds one of the Courtis Map Test, but besides a map of the United States it uses a large map of the Americas, a map of Europe and a map of the eastern hemisphere, all of which might be used with the blind.

XII

Words Are Wise Men's Counters (*Hobbes*): How Rich Are the Blind?

CHILDREN often use words whose meaning they do not understand. They may be simply imitating the speech of adults as they imitate gestures and facial expressions. They may be experimenting with words, as they do with actions, to see what effect they will have upon their companions, parents or teachers. A story is told of a small boy who treasured a very naughty word which he used only when angry, and even then he whispered it, fearing its great potency. His word was "perspiration!" Children may also use adult words to bolster up the ego, to assure themselves that they are advancing up the perilous climb to adulthood, to prove that they are growing up.

Insecurity, or some uncomfortable sense of limitation or inferiority, probably motivates much of the verbal showing off of high school boys and girls, the "fine writing" and bombastic oratory which cause so much anxiety to teachers of English. Much political speech-making appears to be intended to impress rather than to instruct the listeners and the strange polysyllabic constructions attributed to negroes and to white hoboes in the funny papers go still farther back into the narcism of childhood. Ritchie (6, p. 193) thinks that the blind are particularly prone to make errors of this sort and that they are used as an unconscious defense mechanism.

> Many blind people have a fondness for big words. In writing they affect the grand, the Johnsonian, manner. The modern cult of the conversational in style leaves them cold. They roll the word of many syllables lovingly round the tongue and quickly respond to like eloquence in others. That such a trait is allowed to persist

after school-days is a reflection on the current teaching of English, for the misuse of words is, in most, an eradicable failing; but the real point at issue is that, to a degree distinctly greater than their seeing comrades, blind adolescents and adults have a tendency towards this weakness.

Of course, the mechanism of defending oneself from the unpleasant, perhaps unbearable, recognition of inferiority is very common in all phases of social life. Morgan (5, p. 543) suggests that whenever a person manifests any trait to an extreme degree, we should consider the possibility of an attempt to cover up the opposite trait.

> If a person is extremely arrogant, consider a compensation for a feeling of insufficiency. If a person is extremely unselfish, consider a compensation for undesirable selfishness. [Of this he gives an interesting example on page 518.] If a person is too angelic in his conduct, suspect an attempt to submerge a tendency to be bad. If he is extremely bad, if he shows that he is trying to be bad, look for a reaction against a fear of being a "goody-goody." While such assumptions may not always be correct, they furnish working hypotheses. It is surprising how often they turn out to be correct.

Ritchie continues in the same vein and applies this explanation to the actions of the blind (p. 194):

> The undersized man not infrequently carries himself with more than ordinary self-assurance and is of an unalterable conviction that it is quality and not quantity that counts. Can the verbal exuberance of the blind be fitted in any such category? Can we not trace in this mental phase a revolt against the galling conviction of his inferiority? His subconscious mind sets about redressing the balance. If he is handicapped in regard to vision, there are other regions of activity in which no disability exists. The use of words is one of these, and he strives by an exaggeration of literary language to show his superiority to the average man. For the same reason he makes much of the mistakes that seeing people commit: "Just the silly sort of thing a sighted man would do!" he says, and smiles complacently at the immunity of himself and his friends from such blunders.

This is called the "derogatory technique" by the psychologist and is related to the tendency to attempt to reform others in traits which we fear and are struggling against within ourselves.

Still another difficulty in the development of facility in the use of words is brought to our attention by Cutsforth's (1) discussion of verbalism and the unreality of words to the blind. As a result of our educational methods, children born blind, and to a still greater degree the deaf-blind, acquire a vocabulary which corresponds very slightly to their own sensory experience—a vocabulary of the seeing, a superstructure of words and concepts forced upon them to meet the conventional standards of the world about them. Moreover, he feels that they are discouraged in the use of words from their own experience, and that even when object lessons are given, the emphasis is generally upon elements which are important for the seeing rather than upon what is reality to the blind. "A teacher," he writes (p. 57), "feels that if she shows a child a porcelain model of a frog, she has given reality to his concept of a frog, its size, shape and position. Temperature, slipperiness, movement, all the tactually characteristic frog attributes, as well as its sound, are omitted. Tactually the porcelain frog is scarcely froglike at all. It may look like a frog, but it surely does not feel like one."

This chapter is an attempt to show how efficient blind children are in the *understanding* of words; later we will consider how well they *use* words. Two main lines of evidence will be presented: (1) The results of the Terman Vocabulary Test given to classes by the group method and to individuals in the course of the Binet testing; and (2) the results of the Word Meaning Test in the Stanford Achievement Test series. Full details are given for the use of these tests in the grades, with methods of scoring and suggestions for interpretation of results.

Terman's English Vocabulary Test (2)

Object.—The purpose of this test is to determine the extent of the pupils' reading vocabulary and to discover about how many words the pupils can understand when read or heard. This test also correlates high with tests of general intelligence.

Material.—The first 50 words in Terman's (7) Vocabulary Test.

Method.—Pass around blank sheets of paper and have the pupils write name, age, grade and the date at the top. Then say:

"I want to find out how many words you know. I shall read you a list of words, one at a time. After I have pronounced a word, I want you to consider whether you could *define* it as exactly as words are ordinarily defined in a dictionary. If you could define it, write the number of the word and a capital D for define, on your papers. If you could not define it but could *explain* it well enough to give some idea of its meaning to one who is not familiar with it, write the number of the word and a capital E for explain. If the word is only roughly *familiar* and not a word that you could explain, write the number of the word and a capital F for familiar. If the word is entirely *new* and unknown, write the number of the word and a capital N for new. For instance, take the word 'budget.' The dictionary *defines* this word by explaining that originally it meant a small bag, but is now generally used figuratively as 'a budget of news.' In England it is used as a name for the annual financial statement of the government, with an estimate of probable income, expenses, etc. One might *explain* the word in a few words, as an estimate of one's income and expenses. It might be vaguely *familiar* to one because he had heard his parents make some reference to the household budget, without any clear idea of its meaning. If one had never heard the word, and had no idea what it could mean, he should report it as *new*. To repeat, after I have pronounced a word, you are to write its number and one of the following letters: D for define, E for explain, F for familiar, or N for new.

"Write across your line, putting five replies on each line. When five words have been given I shall reread the list of five and ask you to select one word to define. You will then be given plenty of time to write your definition of the word you select. There are fifty words in all.

"Does everyone understand?"

After answering questions give the words in order, allowing plenty of time for the consideration of each word. Spell any words which you think might not be understood from the sound, or about which the children ask questions. Watch the pupils to see that they do not write the whole word each time. Give the test in the following form:

"The first word is 'gown.' Write number 1 and one of the letters, D for define, E for explain, F for familiar, or N for new. Do not write the whole word, just its number and a letter.

"The second word is 'tap.' Write number 2 and one of the letters, D, E, F or N. The word is spelled t-a-p," etc.

When five words have been given, say:

"I will now reread the five words I have just given. Please pick out one and write me a definition of it."

Then read the five words slowly and allow time for all to finish their definition, unless you think some are loitering. Say:

"Ready now for the sixth word," and continue to the end, stopping after each five words for the pupils to write definitions.

Scoring.—The scoring is somewhat complicated because we cannot be sure that the pupils know all the words they claim to know, and in various cases we have found pupils writing D's and E's for words they could not explain sensibly. The steps in scoring are as follows:

Determine the *rough score* by counting up the D's, E's and F's, allowing one point for each D or E, and one-half point for each F.

Since we cannot be sure that the pupils have not over-estimated their knowledge, we then study over their definitions of words they claimed to be able to explain, and grade each definition on a scale of 100. By adding these grades together and dividing by the number, we get an *average value* for the definitions.

Upon the assumption that the pupil would perhaps have done just as well if he had attempted to define other words for which he reported a D or an E, we multiply the rough score by the average value of the definitions and thus get an *accredited* score, which probably represents his real knowledge fairly well.

Dividing the accredited score by fifty, the whole number of words in the list, gives us a *per cent of correctness* on the test.

Multiplying this per cent of correctness by 18,000, the total number of words in the dictionary from which our list was taken haphazardly, gives us the *probable vocabulary* of the child tested.

Our formula then is:

Rough score × average value of definitions = accredited score
Accredited score ÷ 50 = per cent of correctness
Per cent of correctness × 18,000 = probable vocabulary

Illustration:

Pupil A writes D or E after 20 words	value 20
Pupil A writes F after 10 words	5
Rough score	25

Pupil A writes 6 definitions with an average value of 80 per cent
25 × 80 per cent = 20, our *accredited score* 20 ÷ 50 = .40
40 per cent of 18,000 = 7,200, the probable vocabulary.

Terman's List of 50 Words

gown
tap
scorch
puddle
envelope
rule
health
eyelash
copper
curse
pork
outward
southern
lecture
dungeon
skill
ramble
civil
insure
nerve
juggler
regard
stave
brunette
hysterics
Mars
mosaic
bewail
priceless
disproportionate
tolerate
artless
depredation
lotus
frustrate
harpy
flaunt
ochre
milksop
incrustation
retroactive
ambergris
achromatic
perfunctory
casuistry
piscatorial
sudorific
parterre
shagreen
complot

TABLE I. RESULTS OBTAINED IN EIGHT SCHOOLS FOR THE BLIND WITH TERMAN'S ENGLISH GROUP VOCABULARY TEST

Ages	Number of pupils tested	Median scores	Standards for the blind	Standards for the seeing
10	..	....	....	4680
11	26	5750	5250	5400
12	36	4250	5417	6480
13	30	6250	5750	7560
14	47	5750	6083	9000
15	57	6250	6417	....
16	58	7250	7417	11700 (average adult)
17	63	8750	8417	....
18	47	9250	9250	13500 (superior adult)
19	32	9750	10250	....
20	19	11750	11250	....
21	15	12250	11907	....
22	7	11750	10917	....
23 and up	6	8750	9750	....
Total	443			

Interpretation.—Table I seems to indicate a definite, annually increasing deficiency in vocabulary for the blind, though the small number of cases makes the curve irregular. Smoothing the curve of median scores to obtain tentative standards for the blind, we find the eleven-year seeing standard reached by the blind at twelve years, the twelve-year seeing standard reached by the blind at fifteen years, the thirteen-year seeing standard nearly reached by the blind at sixteen years, the fourteen-year seeing standard reached by the blind at eighteen years, the sixteen-year, or average adult, seeing standard reached by the blind at twenty years, and somewhat exceeded at twenty-one, after which there is a rapid decrease in scores which may easily be accounted for by the graduation of the brighter pupils before this age. The seeing standard for eighteen years (superior adult) is far above the highest median score for any year group of the blind, though a few bright pupils from sixteen years on made scores indicating a vocabulary of more than 13,500 words. It is not surprising to find blind children testing below the seeing in vocabulary. The slowness and laboriousness of their reading puts a natural limit upon their chances of meeting new words in literature, and their restricted life experience in residential schools cuts them off from many currents of practical life. When these same words are used in the Hayes-Binet tests given individually with the request for an oral definition of each word, we find the same decided inferiority to the seeing, so we feel sure that there is nothing in the method of giving this as a *group* test which puts the blind to an unfair disadvantage. Table II gives the results of the *individual* Binet testing with very large numbers of students, a total of 1600 before 1930 and 2233 from 1930 to 1936. It will be observed that even when two years' retardation was allowed by setting the standards for the blind two years later than for the seeing, the blind fell progressively further behind the seeing from fourteen years onward, the fourteen-year seeing standard of fifty words not being passed by a satisfactory percent of the blind until twenty years, and the sixteen-year seeing standard of sixty-five words not being attained at all, by any age group.

Teachers will be interested in Terman's (7) discussion of this test, when given individually in a Binet examination. Writing in 1916, when his revision of the Binet tests was first published, he said (p. 230):

> The vocabulary test has a far higher value than any other single test of the scale [which then consisted of sixty-eight regular tests and sixteen alternates]. Used with children of English-speaking parents (with children whose home language is not English it is of course unreliable), it probably has higher value than any three other tests in the scale. Our statistics show that in a large majority of cases the vocabulary test alone will give us an intelligence quotient within 10 per cent of that secured by the entire scale. Out of hundreds of English-speaking children we have not found one testing significantly above age who had a significantly low vocabulary; and correspondingly, those who test much below age never have a high vocabulary.
>
> Occasionally, however, a subject tests somewhat higher or lower in vocabulary than the mental age would lead us to expect. This is often the case with dull children in cultured homes and with intelligent children whose home environment has not stimulated

TABLE II. RESULTS OF THE TERMAN VOCABULARY TEST GIVEN INDIVIDUALLY WITH ORAL RESPONSES IN THE HAYES-BINET TESTING (3)

Attainments of the blind						Terman's standards for the seeing		
Tested before 1930			Tested 1930-36					
Age when tested	Number of words they should know	Per cent passing	Age	Number tested	Per cent passing	Age	Number of words they should know	Per cent passing
			8	98	39	8	20	60-65
			9	133	41			
10	20	36	*10*	166	59	10	30	60-65
			11	182	74			
			12	166	77			
			10	156	32			
			11	185	39			
12	30	41	*12*	187	50	12	40	60-65
			13	169	66			
			14	152	72			
			12	154	27			
			13	149	35			
14	40	46	*14*	164	50	14	50	60-65
			15	140	59			
			16	165	59			
			17	122	70			
			14	151	23			
			15	126	34			
16	50	32	*16*	160	34	16	65	60-65
			17	127	50			
			18	120	47			
			19	103	56			
			20	56	66			
			16	143	15			
			17	116	20			
18	60	35	*18*	116	32	18	75	60-65
			19	100	23			
			20	57	40			
			21	57	39			
			21+	63	43			

language development. But even in these cases we are not seriously misled, for the dull child of fortunate home surroundings shows his dullness in the quality of his definitions if not in their quantity; while the bright child of illiterate parents shows his intelligence in the aptness and accuracy of his definitions.

In the 1937 revision of the Binet tests, Terman (8) reduced his list from one hundred to forty-five words, carefully arranged them in order from easy to difficult and extended their use down to the sixth year. Again he says that this is the most valuable single test in the scale. "Its interest value is high," he writes (p. 302). "It presents a familiar task to the subject, and the fact that it begins with words in common use and increases rapidly in difficulty gives the examiner a rapid survey method of estimating the subject's ability. It agrees to a higher degree with the mental age rating on the scale as a whole; correlations for single age groups range from .65 to .91 with an average of .81."

For retesting, Terman's second list of fifty words may be used, and scores compared to indicate progress. There is now a considerable variety of vocabulary tests available for all the grades, high school and college. Hildreth (4, p. 63) lists forty-two articles on vocabulary tests and names of tests, including the test developed by M. Smith in her "Investigation of the Development of the Sentence and Extent of Vocabulary in Young Children" (Iowa Studies in Child Welfare 1926, 3, No. 5), the Hill Test of Word Meanings for Primary Grades (Bloomington, Illinois: Public School Pub. Co., 1930), the Los Angeles Sentence Vocabulary Test, for grades three to nine (Los Angeles: Southern California School Book Depository, 1926), O'Rourke's Survey Test of Vocabulary, for grades three to thirteen (New York: Psychological Corp., 1931), and O'Connor's Work Sample No. 95—Vocabulary for college students (Boston: Ginn and Co.). Any of these may be adapted for use with the blind in much the same way as the Terman test discussed above, or the Stanford Achievement Test described below.

THE NEW STANFORD ACHIEVEMENT TEST, NO. 2, WORD MEANING

Object.—The purpose of this test is to measure the pupils' knowledge of words likely to be met with in general reading. The multiple-choice-completion method of testing is used. Two types of items have been included: those in which the critical word is harder than the response word, and those in which it is easier. Care was taken to see that a reasonable sampling of the parts of speech (nouns, verbs, abjectives, adverbs) would be represented and the response word and the critical word for a given item are nearly always of the same part of speech—both nouns, verbs, etc.

Material.—From the American Printing House for the Blind, order one specimen set of inkprint material in one of the five forms of the test—V, W, X, Y or Z—and enough braille pamphlets of the *same form* to provide one copy for each pupil. Each form of the test consists of eighty incomplete sentences, the first part of each sentence being followed by five words, one of which will satisfactorily complete the sentence, as for example:

1. Cheese is: bread drink food gold time
2. A baker makes: dresses hats shoes bread suits
3. An oak is a kind of: box corn egg money tree
4. A dove is a: bird boat fish horse sheep
5. A chimney is for: bees games smoke snow soil

The sentences are listed in order of difficulty, the easiest appearing at the beginning and the most difficult at the end of the test. These sample sentences are taken from Form Y. Since there are five equally difficult forms of the test, it is possible to test pupils at the beginning and the middle or end of the year, and in succeeding years, to show progress, without the danger that memory of a former test might invalidate the results of a later one. Norms are established for years and months of age, and for grades and tenths of a grade, so it is possible to check results against standards in any month in the school year. Used test sheets also are very good review material.

Complete directions for giving and scoring this test may be found in Chapter IX.

Interpretation.—As we have rather complete norms for this test, teachers will be interested in making a number of scatter diagrams, by chronological age, by mental age, and by grade, and perhaps also by I. Q., by classroom work in reading, by age at loss of vision, by number of years in school, and by reading rate as determined by some objective test. Directions for making scatter diagrams may be found in Chapter X. We have not found scatter diagrams and curves by chronological age very satisfactory and generally form them by mental age for our study and by grades for the benefit of teachers. Tables III and IV give the results obtained with this test in two schools for the blind in two succeeding school years. These tables may appear complicated but they are simple enough when the method of forming them is understood. Table III should be read as follows: In grade 9, 22 pupils were tested in November '35 and obtained an average score of 100 points. As the norm for the seeing for this grade in November is 97, these children tested above the seeing, their efficiency being indicated by 103 per cent of the norm, a figure obtained by dividing the average score by the norm. School B was tested in February when the norms would naturally be somewhat higher. So we find the 8 pupils in grade 9, whose average score was 88 points, rising only to 89 per cent of the norm. When the two schools are combined and December norms used, considering December as intermediate between November and February, we find the 30 pupils in grade 9 testing at 99 per cent of the norm. As one studies the table, giving particular attention to the columns headed "per cent of norm," it appears that both schools test pretty close to the seeing standards by grades, 4 of the 6 per cents of norm being above 100 in each column. Much the same situation obtains in Table IV, though there is a slight change in the relative success of the two schools. In the first testing reported in Table III, School A was slightly superior to School B; in the second testing reported in Table IV, School B is somewhat superior to School A. In both schools, the teachers are justified in concluding that their pupils are doing about as well in this test as one would expect of them.

Having determined whether or not their grades are testing up to standard, teachers will also wish to study the individual scores, considering whether their pupils with high scores are the ones of whom they would expect this, trying to account for low scores made by good pupils, noting changes from high

Table III. Results, in Two Schools for the Blind, of the Stanford Achievement Test, No. 2, Word Meaning, Arranged by Grades

	School A, Tested in Nov. '35				School B, Tested in Feb. '36				Two schools combined			
Grade	No. tested	Av. score	Norms for Nov.	Per cent of norm	No. tested	Av. score	Norms for Feb.	Per cent of norm	No. tested	Av. score	Norms for Dec.	Per cent of norm
9	22	100	97	103	8	88	99	89	30	97	98	99
8	18	94	91	104	18	94	93	101	36	94	91	104
7	15	88	84	105	17	86	86	100	32	87	85	102
6	17	78	76	103	12	81	78	103	29	79	77	103
5	13	62	65	96	11	65	68	94	24	63	66	95
4	17	48	52	92	12	61	57	105	29	53	53	100

Table IV. Results, in Two Schools for the Blind, of the Stanford Achievement Test, No. 2, Word Meaning, Arranged by Grades, Second Year of Testing

	School A, Tested in Dec. '36				School B, Tested in Oct. '36				Two schools combined			
Grade	No. tested	Av. score	Norms for Dec.	Per cent of norm	No. tested	Av. score	Norms for Oct.	Per cent of norm	No. tested	Av. score	Norms for Nov.	Per cent of norm
9	15	98	98	100	11	101	96	105	26	99	97	102
8	15	97	91	107	18	95	90	106	33	96	91	105
7	19	85	84	101	15	87	83	105	34	86	84	102
6	8	76	77	99	8	77	75	103	16	77	76	101
5	18	55	66	83	13	66	64	103	31	60	65	92
4	9	47	53	88	10	45	50	89	19	46	52	88

to low, or vice versa, from the first to the second year of testing. Some teachers may be interested to work out correlations for their grades by the simple method outlined in Chapter IX and illustrated in Chapter XI.

Table V gives the results obtained in the two schools in 1935-6, arranged by mental age. This method of tabulation is particularly suitable for this test as it is really a simple vocabulary test and so would be expected to show a high correlation with intelligence. Examination of the columns headed "per cent of norm" in Table V gives one quite a different impression of the facility of blind children in dealing with word meanings from the conclusion drawn from Table IV. Here we find few groups testing at 100, the per cents for School A ranging from 103 down to 80 with a median at 90, while the per cents for School B ranged from 142 down to 67 with a median at 84. When the two schools are combined, and single scores have less effect on the average scores, we find a median at 90, or approximately 10 per cent below the standards for the seeing. Translated into age comparisons, we may say that at 9 and 10 M.A. the blind do decidedly better than the seeing; from 12 to 15 M.A. they show a retardation of about one year; and from 16 M.A. on they are retarded two or three years. A similar situation was discovered when these schools were retested the following year with another form of the test. These results remind us of the progressive retardation discovered with the Terman vocabulary tests, and are doubtless to be explained in the same way. The blind are enormously handicapped in their acquisition of language in comparison with seeing children who are constantly enlarging their vocabularies through wider and wider reading, either in books or in newspapers, and being about two grades ahead of the blind in all the grades, they naturally have richer textbook material, while their greater freedom of action brings them more varied life experiences and their inevitable linguistic accompaniments.

TABLE V. RESULTS, IN TWO SCHOOLS FOR THE BLIND, OF THE STANFORD ACHIEVEMENT TEST, NO. 2, WORD MEANING, ARRANGED BY MENTAL AGE

	School A, Tested in Nov. '35				School B, Tested in Feb. '36				Two schools combined			
M.A.	No. tested	Av. score	Norms for Nov.	Per cent of norm	No. tested	Av. score	Norms for Feb.	Per cent of norm	No. tested	Av. score	Norms for Dec.	Per cent of norm
19	3	106	119	89	4	98	121	81	7	101	120	84
18	6	101	116	88	8	89	117	76	14	94	116	81
17	13	96	111	86	8	90	113	80	21	94	112	84
16	12	94	104	90	15	84	106	79	27	88	105	84
15	16	91	97	94	7	83	99	84	23	89	97	91
14	10	83	92	90	9	83	93	89	19	83	92	90
13	10	78	86	91	5	88	87	101	15	81	86	94
12	9	77	77	100	6	71	79	90	15	75	78	96
11	11	53	66	80	4	46	69	67	15	51	67	76
10	9	52	53	98	5	62	56	111	14	56	54	104
9	4	40	39	103	4	61	43	142	8	50	40	125

Some day it will be interesting to determine whether the wide use of the Talking Book has resulted in lifting the vocabularies of the blind nearer to those of the seeing, somewhat as the radio has brought to the masses a wealth of musical information which a generation ago was possessed only by a few who had enjoyed a special musical education.

Summary

We have raised the questions whether compensation for a sense of inferiority due to blindness might predispose blind children to a conspicuous use of large words, and whether our educational methods tend to distort their vocabulary by overemphasis on words based upon vision to the neglect of words which are closer to their actual experience with the world of objects. We have presented evidence of the degree of their competence in dealing with standard vocabularies, and given detailed instructions for the use of two important group tests planned to measure appreciation of the meanings of words. So far as our results go, they indicate, among the blind in thirteen residential schools, an inferiority in the understanding of words about equal to their educational retardation in the early grades, with a progressively greater inferiority in later adolescence where longer words and specialized, abstract terms form a larger proportion of standard vocabularies. As the same trend is evident in all of the schools tested, we cannot look to local differences in methods of teaching for an explanation. A careful inspection of the particular vocabularies used does not disclose a preponderance of purely visual terms which would make the tests unfair to the blind or lower their scores on the assumption of excessive verbalism. Our curves of results take the normal bell-shaped form with small numbers of very inferior and very superior pupils at the extreme ends of the curves. It is quite possible that some of those who show great superiority may have specialized in "big words" as a form of compensation, but one must be cautious about an unlimited use of this idea. It seems safer to assume that in this matter we are dealing with the "fallacy of the single case": conspicuous individuals with good native intelligence may be making the most of their linguistic abilities, and by attracting attention to themselves, may give us the impression that such a reaction is a common response to blindness. Our results from the testing of large numbers of unselected blind pupils, however, seem to show that the average blind child could not make much of a display with difficult words, because he does not know them when they appear in the tests. If he uses polysyllabic words, except as trial balloons, his search for security will receive shocks and set-backs which will be most disconcerting. Teachers may greatly assist blind children in developing from the childish to the adult use of vocabulary. Aside from the careful explanation of all new words as they occur in textbooks and classroom discussion, and an alert attitude toward new concepts in the newspapers and on the radio, it might be worth while to make a consistent direct attack upon the problem. According to Terman's standards, children's vocabularies should increase from the twelfth to the eighteenth year at the rate of more than one thousand words per year, if the children are bright enough to absorb the material that comes their way in the process of education. Might it not be possible to assure the regular acquisition of a considerable number of new words every school year by an extension of the spelling course into the upper grades and the high school where the deficiency in vocabulary is more evident? Twenty-five new words per week, or five new words per day, for the forty weeks of the school year would accomplish this result. Thorndike's (9) *Teacher's Word Book* could be used to good advantage. And the systematic study of new words with a consideration of their derivation, the changes in form and meaning which have occurred through the years, and wherever possible, experience of their meaning in terms of other senses than vision, should greatly enrich the whole curriculum.

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XIII

What Do Blind Children Know?

One of the earliest aims of education was to pass on to the young the knowledge accumulated in the life experiences of their elders. Wise parents patiently answer their children's incessant questions and wise teachers strive to keep the questioning spirit alive throughout the school years. We expect the most desirable vocational opportunities to be offered to graduates who have made the best use of their chances for education; and to those who have become experts in any line the public is glad to go for information and guidance. A certain reverent respect is given to those who enter the professions, to great statesmen, and to public leaders. Naturally, then, we are all interested in the progress of the young at various stages; their educational successes and their failures at any level become matters for serious consideration.

Many years ago a number of educators startled the public with an exposé of glaring deficiencies in the mental equipment of children entering school, and similar failures in the educational process at later stages have been reported from time to time. In 1880, G. Stanley Hall (2) made a survey of the common knowledge possessed by children entering the Boston public schools which led to the striking conclusion "that there is next to nothing of pedagogic value the knowledge of which it is safe to assume at the outset of school life," and induced him to recommend that "the best preparation parents can give their children for good school training is to make them acquainted with natural objects, especially with the sights and sounds of the country." Besides tables of results showing a "high rate of ignorance," Hall quotes many surprising misconceptions:

> Skeins and spools of thread were said to grow on the sheep's back or on bushes, stockings on trees, butter to come from buttercups, flour to be made of beans, oats to grow on oaks, bread to be swelled yeast, trees to be stuck in the ground by God and to be rootless, meat to be dug from the ground, and potatoes to be picked from the trees. Cheese is squeezed butter, the cow says "bow wow," the pig purrs or burrows, worms are not distinguished from snakes, moss from the "toad's umbrella," bricks from stones, etc. An oak may be known only as an acorn tree or a button tree, a pine only as a needle tree, a bird's nest only as its bed, etc. So that while no one child has all these misconceptions, none are free from them, and thus the liabilities are great that, in this chaos of half-assimilated impressions, half right, half wrong, some lost link may make utter nonsense or mere verbal cram of the most careful instruction as in the cases of children referred to above, who knew much by rote about a cow, its milk, horns, leather, meat, etc., but yet were sure from the picture book that it was no bigger than a small mouse. . . . . . When hams are said to grow on trees or in the ground, or a hill is described as a *lump* of dirt, or wool as growing on hens, as sometimes occurs, deficiency is obvious.

With the rise of intelligence testing at the end of the century, items calling for information upon everyday experiences were always included, especially in the tests for the lower years, on the assumption that a bright child would pick up more miscellaneous knowledge than a dull child. In the Stanford-Binet tests (7) an average three-year-old is expected to be able to point to parts of his body, to name familiar objects, to give his sex and his last name; an average five-year-old to name the colors *red*, *yellow*, *blue*, and *green*, to give definitions of *chair*, *horse*, *fork*, *doll*, *pencil*, and *table*, and to know his age. In group tests of intelligence similar items appear, with increasing dependence upon school knowledge as the years go on. But here and there are children of fair ability and various ages who suddenly fail upon matters of everyday experience, leading one to apply Hall's caution at every stage of the educational process. Even the selected group that goes to college is no exception to the rule, for we learn that when the information sheet of the Army Alpha test (9) was given to college freshmen, most surprising errors occurred:

> Simple biological facts that are supposed to be in common knowledge and parlance are outside the mental realm of many of the college students, or are confused within it. 4 per cent of them would be willing to ask a dairyman if his cows are Leghorns. And when we discover that 6 per cent do not know what an artichoke is, while 6 per cent more assert it to be a fish, 3 a lizard, and 1, no doubt thinking of the strangling powers (choke) of a boa constrictor, claims that it denotes a snake, we cannot but wonder in what world these 16 per cent received their information—or lack of it. But we get a real shock when we discover that a chameleon is voted a member of the bird, insect, and fish families by 23 per cent, 4 per cent, and 4 per cent of the group, respectively; while another 13 per cent give up the problem of classification as a thing impossible; so that one can safely say that only a little over one-half of the number really knows that a chameleon is a reptile that changes its color but not its genus. Thirty per cent do not know the location of the thyroid gland, and either refuse to detail their ignorance concretely, or place it indiscriminately in the shoulder, head or abdomen, the handy receptacle for all physiological x's and y's. One daring soul even had the audacity to state that rubber is made of hides.
>
> Geography does not make any better showing; in fact, even a lower grade of recognition is exhibited. It need not affect the world's happiness greatly if a certain third of our student body would take a liner for China if their destination were Tokio, for the name of this Oriental city does sound Chinesy, and it is a personal matter, anyway; and, besides, this method of instruction would be effective and according to sound pedagogical principles. But it would be a decided affront to some of our time-honored American institutions if they should learn that out of one hundred students who wish to attend Yale University, four would have to look in the atlas to know what part of the world they were bound for, while six would purchase railway fares for Ithaca, and thirty-six would proceed blithely on their way to Cambridge. But once

arrived in New England, two of them would be forced to the discovery that Boston is not a city of Maine, and one would find, not without surprise, that Massachusetts, instead of Connecticut, claims the honor of harboring "the Hub." Such are the educational possibilities of travel.

Every school for the blind probably has quite a collection of stories illustrating the misconceptions and misunderstandings of blind children. Perhaps our recital of the errors of the seeing will make those of the blind seem less queer. To be sure, the blind child was in error when, according to the familiar story, she said, "A chicken has four legs," but her mistake seems almost inevitable when her reason is given—"Whenever we have chicken at home there are always four drumsticks!" In order that teachers may discover whether, and to what degree, blind children are inferior to the seeing in everyday knowledge, a few representative tests are presented:

A. Sangren Information Tests for Young Children (6)

Object.—The purposes of this test are: (1) to call attention to the need for greater definiteness and certainty in nursery and kindergarten instruction, (2) to determine what young children at various stages of maturity and various stages of instruction do know, (3) to attempt to fix some standards of promotion and placement of children in the early years of their educational careers, and (4) to provide a basis for instructional practices and classroom management at the beginning of the first grade.

Materials.—One examination manual for the tester and an individual record blank for each pupil to be tested, from World Book Co., Yonkers-on-Hudson, New York.

Test 1 (Nature Study) consists of twenty-eight questions like the following: (1) "Tell me, what is this table made of?" (2) "What do birds make their nests of?" (3) "Which farm animal gives us milk?"

Test 2 (Numbers) consists of seventeen questions beginning with: (1) the counting of groups of three, five, and eight stars and all the stars together; (2) "Who is the older (oldest), you or your father?" (3) "Which of these four squares is the biggest? Which is the largest?"

Test 3 (Vocabulary) calls for the definition of thirty-five words: (1) "Show me something red;" (2) "What is a hat?" (3) "What is a basket?"

Test 4 (Social and Civic Information) consists of thirty questions: (1) "What does a milkman do?" (2) "What is your name?" (3) "Why must people walk on the sidewalk instead of in the street?"

Test 5 (Household Knowledge) consists of sixteen questions beginning with: (1) the naming of seven dishes and table implements from a picture (omitted in testing the blind); (2) "What is a broom used for?" (3) "What is the cupboard in the kitchen used for?"

Test 6 (Language and Literature) consists of nine parts: (1) A little story is read and seven simple questions are asked about it; (2) a little poem is read and five questions are asked about it; (3) a simple riddle is read and the child is asked, "What is the story about?"

Method.—Follow the directions for giving and scoring as printed in the manual, with the following minor changes: In Test 1 omit items 7, 19 and 20; in item 8 a toy bird may be used instead of the picture; in item 10 say, "Which one of these things grows on a tree: an ear of corn, a carrot, a bunch of grapes, an apple, or a rooster?" In Test 2 present the material for items 1, 3 and 4 tactually; in 1 using dots for the stars, in 2 using squares with sides twice as long and twice as far apart as those in the ink copy, and in 4 using lines twice as long and twice as far apart as those printed. Omit items 10 and 17. In Test 3, item 1, instead of "Show me something red" say, "Tell me about something that is red." Make the same change in item 14. In Test 4 omit items 9 and 19. In Test 5 omit items 8 and 11, and in item 1 use samples of the objects pictured. In Test 6 omit items 3 and 8. The omissions suggested reduce the possible scores for all the tests except 3, and decrease the total maximum possible score from 190 to 152 points. These reductions must be taken into account in comparing the blind with the seeing, six points being deducted from the norms for Test 1, thirteen points in Test 2, three points in Test 4, six points in Test 5 and ten points in Test 6. It may be possible later to suggest substitutions of equivalent material to bring the possible scores up to the original figures.

Results.—A preliminary trial of the Sangren Information Tests at Perkins Institution with thirty-five children in the kindergarten, first and second grades, indicated that these tests might give significant evidence of the mental status and educational promise of young children, thus forming a valuable supplement to the Hayes-Binet intelligence tests, with which they show a high correlation. Considering the small number tested we do not feel justified in presenting the numerical results, but in summary we may say: (1) that the blind kindergarten children tested practically equal to Sangren's seeing norms in all the tests except No. 1, Nature Study, in which the blind were distinctly inferior; and (2) that the blind first grade children tested above the seeing in No. 6, Language and Literature, about equal to the seeing in No. 4, Social Science, and below the seeing in the other four tests. The profile chart printed on the record sheet proved exceedingly valuable in bringing to the attention of the teachers each child's special strengths and weaknesses, with a clear indication of the points at which remedial work was needed. Here, as in the average results by grade, the weakness in Nature Study and the relatively strong position in Language and Literature are obvious.

An analysis of errors disclosed some interesting points which have guided us in omitting or modifying some of the items when used with the blind. Although models of animals were carefully selected and substituted for the six pictures in Test 1, item 7, we are not surprised to find that very few children could identify more than two correctly. The dog, sheep, and horse were known best; the elephant was frequently called a cow or a bear, while the kangaroo was judged to be a squirrel or a monkey; the model of a lion, which was substituted for the rhinoceros of the picture, was often called a rat or a pig!

Obviously this test should be omitted. Apparently the children's vocabulary of animals was very limited and many were unable to give the names of three animals found in a city park or zoo, as required in Test 1, item 18. Naturally, they failed on Test 2, item 17, when asked to read numbers; few blind children learn to read before entering the second grade, so this test and Test 4, item 8, should be omitted. In the vocabulary Test 3, such words as post, carry, business, raise and piece were stumbling blocks, but the total scores compared favorably with those of the seeing. In Test 5, item 1, the dishes and table silver were easily recognized by touch, but the blind children were not able to name the kitchen utensils of 5, item 8, doubtless because they are too young to have had cooking experience; so the latter test is to be omitted. They do not know what animal beef comes from nor why garbage should be destroyed. In fact, the word *garbage* had to be explained to many of them. But when asked, "How does your mother can fruit?" (Test 5, item 14), some of them gave the up-to-date answer, "She buys it." In Test 6, item 3, the riddle about the stars is obviously unsuited to the blind and should be omitted.

B. Pressey Test of Practical Information

Object.—The purpose of this test is to measure the pupils' knowledge of objects and ideas of common occurrence in everyday life.

Materials.—An embossed sheet containing the following words, slightly modified from Pressey's Group Point Scale, test 9. This material may be obtained through the American Printing House for the Blind.

Method.—Pass around sheets of paper and have pupils write name, age, grade, and the date at the top. Then pass the sheets for the test and say:

"On the sheets I have given you, you will find a number of groups of words. The first group reads—'man, cow, hen, dog, cat.' Now which of these five animals usually lives the longest?" Get the answer, "Man." "Which one usually lives the shortest time?" Get the answer, "Hen." "Write the names of these two animals on your sheets."

When all have finished writing, say:

"Now look at the second group—'train, mule, horse, bicycle, steamboat.' Of these five, which goes the fastest?" Get answer, "Train." "Please write that down." "Which goes the slowest?" Get answer, "Mule." "Write that down."

"Now you will work through the other lists and write the answers without saying them aloud. Read the list numbered 3 and decide which thing is the heaviest and which is the lightest. Write these down on your papers, the heaviest first and then the lightest. Use a new line for each list of words."

Allow one minute for writing and then say: "Now look at group number 4 and decide which thing is hardest to break and which is easiest to break. Write these down, first the hardest to break and then the one that breaks easiest." It is not essential that the pupils be limited to exactly one minute, but this time will probably be sufficient.

Examples

1
man
cow
hen
dog
cat

2
train
mule
horse
bicycle
steamboat

3
water
wood
cork
sand
iron

4
string
glass
steel
pencil
paper

5
milk
salt
bread
fish
meat

6
drop the handkerchief
football
baseball
hide and seek
checkers

7
Fourth of July
Washington's Birthday
Memorial Day
Thanksgiving Day
Labor Day

8
scissors
chisel
plane
saw
knife

9
policeman
sheriff
senator
mayor
representative

10
bill
coins
check
money order
stamps

11
smallpox
scarlet fever
measles
tuberculosis
diphtheria

12
weaver
riveter
typesetter
coal picker
cabinet maker

Allow one minute for writing and then say: "Now look at group number 5 and decide which thing costs most and which costs least. Write these two, first the one that costs most, and then the one that costs least."

Proceed in similar fashion with the others, repeating the directions each time, as in the above examples.

6. The game that requires most people in order to play it, and the game that requires the fewest.

7. The holiday that comes nearest to New Year's Day and the holiday that comes nearest to the middle of the year.

8. The tool that is hardest to sharpen and the tool that is easiest to sharpen.

9. The most important man and the least important man.

10. The safest way to send money and the least safe way.

11. The disease that it takes longest to get well from and the disease that one recovers from most quickly.

12. The man who must have most skill and the least skilled worker.

Scoring.—Score the pupils' papers according to the following key. Allow one point of credit for each correct answer. If two correct answers are given, but in the wrong order, allow one-half credit for each; if one correct and one incorrect answer are given, but in the wrong order, allow one-half credit for the correct answer. If more than two answers are given for any group, allow no credit. The maximum possible score is 20. Multiply the score by 5 to get per cent of correctness in the test.

Key for the Pressey Test of Practical Information

3. iron, cork
4. paper, steel
5. meat, salt
6. football, checkers
7. Thanksgiving Day, Fourth of July
8. saw, knife
9. senator, policeman
10. money order, coins
11. tuberculosis, measles
12. cabinet maker, coal picker

Interpretation.—If a single grade is tested, the teacher may be interested to make a scatter diagram of the pupils' scores by age, tracing across the display of scores a curve based on the results obtained through the use of this test with 567 pupils in nine schools for the blind, which we have presented in Table I. If a whole school is tested, a series of scatter diagrams is suggested, based on chronological age, mental age, intelligence quotient, and grade. We have as yet no standards by mental age and I. Q. but interesting points may emerge from the diagrams in any one school. The smoothed curve for the blind in this test is one of the most regular curves we have found, thus indicating that the blind show approximately equal annual additions to the kind of knowledge measured by this test. As one might expect, the blind are distinctly below the seeing in general information, the curves indicating an apparent retardation of four years in each age group from ten to sixteen and of five years in the seventeen- and eighteen-year groups. On the other hand, the possession of sight in the early years of life does not seem to give the pupils any great advantage in this test: the median score for those blinded at birth or during the first three years is 55 per cent in this test, for those blinded in the fourth, fifth, or sixth years, 60 per cent, and for those blinded after the sixth year, 65 per cent. Moreover, some pupils blinded from birth or early infancy make very excellent scores

TABLE I. RESULTS OBTAINED IN NINE SCHOOLS FOR THE BLIND WITH THE PRESSEY TEST OF PRACTICAL INFORMATION

Ages	Number of pupils tested	Median scores in per cent correct	Standards for the blind
9	9	25	28
10	12	35	35
11	33	45	40
12	42	40	47
13	48	55	48
14	63	50	55
15	68	60	58
16	57	65	62
17	69	60	63
18	47	65	65
19	40	70	68
20	79	70	70
Total	567		

in this test, so that one may fairly hope to bring a large proportion of the blind up to seeing levels by enriching their life experience.

C. Measurement of School Achievement

A considerable amount of general information is informally and incidentally acquired by children in the home, on the playground and in the street; this we attempt to measure by tests of practical information. In the schools we try to make sure that all children acquire, more or less systematically, the basal facts and mental tools needed for intelligent citizenship; this we attempt to measure by educational achievement tests.

Since 1916 we have been adapting for use with the blind various typical achievement tests, and in recent years a considerable number of such tests has been described in *The Teachers Forum.* A complete index of these adaptations is given at the end of this book. Perhaps the most significant is the recent adaptation of the New Stanford Achievement Tests in five equivalent forms, making it possible to note children's progress in reading, spelling, language usage, literature, history and civics, geography, physiology and hygiene, arithmetical reasoning and computation. The whole series of tests has been used in one eastern school for five successive years and from one to four times in seven other schools, yielding at least two conclusions pertinent to our topic: (1) Grade for grade the blind children in these schools tested nearly up to the standards for the seeing the first year the tests were used, in all parts of the series except in arithmetical computation, where lower scores were easily explained by consideration of the limitations of their training and the mechanical difficulties in testing; (2) During each succeeding year weak points have been corrected, so that with the single exception noted before, we may say that the pupils in most of these schools test at or above the seeing standards in all their school subjects. In other words, they are well supplied with the information that is disseminated in the school room, and can use it in test situations. A similar conclusion may be drawn from Miss Abel's report

(1), in which she gives the results of the use of another survey achievement test series in the fifth and sixth grades of twelve schools for the blind. She found the median scores of the blind in the fifth grade distinctly above the seeing norms in all but the first test (Reading); a similar superiority appeared in the sixth grade, though to a lesser degree, and with the blind slightly below the seeing in the fundamental operations of arithmetic, in which the fifth grade also was not so superior as in the other tests. This survey included tests in reading, geography, literature, history, problems and fundamental operations in arithmetic, spelling, capitalization, punctuation, and language usage.

From these two surveys we may conclude that grade by grade blind children are acquiring about as much school information as the seeing. Of course, blind children average at least two years older than seeing children in the same grades, so comparisons by age, either chronological or mental, demonstrate their retardation.

Two further measurements of achievement would seem very much worth while, a standard graduation examination to determine whether pupils are ready to leave the elementary grades and begin high school work, and a standardized test for measuring progress in the high school. The latter need is already being met by the use of the Sones-Harry High School Achievement Test (6) in at least one school for the blind; the former need may well be met by an adaptation for the blind of the Otis-Orleans Standard Graduation Examination for Elementary Schools (3). This latter should be a boon to teachers not only in determining in general whether their pupils measure up to graduation standards, but especially in deciding whether some particular boy or girl is ready for promotion to high school work. It might well be substituted for the regular examinations given to eighth grade pupils, as its content is confined chiefly to material taught in that year. The derivation of this examination will show its nature and value. The subject matter was selected in accordance with courses of study and scientific investigations regarding the actual achievement of elementary school pupils and with a view to making the test equally applicable in all parts of the United States. The authors use a variety of questions, not simply to make the test more interesting but rather to suit the type of question to the content and to allow for any possible differences between pupils in their reactions to different types of questions. The spelling words were chosen from the Iowa Spelling Scales: Grade VIII; the reading test consists of five paragraphs, with five questions on each, dealing with geography, science, literature, history and current events; the vocabulary test was formed from Thorndike's *Teacher's Word Book* (8); the items for the tests of arithmetical computation and reasoning were chosen after a careful analysis of several modern texts, not using any computation or topic which did not appear in all these texts; the grammar test, similarly, was based on modern texts, omitting all fine points and technicalities; the language usage test issued from an examination of courses of study and an investigation into the errors commonly made by pupils; for the literature test items were selected on the basis of recent studies of children's interests in literature and courses of study in literature; the history test depends upon an analysis of five widely used texts, the questions being so phrased that they may test reasoning in history rather than a mere memory of historical facts; the geography tests were formed in the same way and with the same purpose, the authors (3) aiming "to test reasoning, to avoid the purely factual type of question, to give adequate stress to the geography of other countries than the United States, and to cover all the important phases of the subject—industries, economic conditions, geographical principles, climate, mathematical geography, etc." The whole examination requires a working time of about three hours for the seeing, ordinarily divided into two sittings, and would require from two to three times this allowance for the blind because of their slower reading and recording of answers; but if the tests were spread out through a week they might be no greater burden than an ordinary series of tests in the same subjects. As five equivalent forms of this standard examination have already been issued, the braille material used in June one year might be used for review purposes the year after; and by preserving records, the attainments of eighth grade classes in successive years might be determined and local standards set. Explicit directions for giving and scoring the Standard Graduation Examination may be found later in this book.

What do blind children know? Specialized tests of practical information have not been widely used with the blind, but where they have been tried we find, besides the confusions and misunderstandings observed in seeing children, various special mistakes and difficulties due to the handicap of blindness. In general, standardized tests of school achievement show just about the degree of inferiority to the seeing which one would expect from their grade retardation. In special lines, like the development of vocabulary, an even greater deficiency is shown.

This chapter recommends a more extended use of standard tests of information and achievement to give an annual check-up on progress in the lowest grades by means of the Sangren Information Tests (5), through the elementary school by the use of the Stanford Achievement Tests (See Chapter IX), at completion of elementary work by the Otis-Orleans Standard Graduation Examination (3) and in the high school by the Sones-Harry High School Achievement Test (6). The results of this testing should show where there is the greatest need for enriching and supplementing the school and life education of blind children.

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XIV

Practical Hints for Testers

When the Binet-Simon Test of Intelligence was first made accessible and the importance of mental testing was brought home to us through its enthusiastic reception by leaders in the fields of education, social work, juvenile delinquency and eugenics, a wave of activity spread over the United States which flowed through schools, courts, clinics and institutions for defectives and swept all before it, carrying away not only some of the debris of unscientific tradition but also many valuable principles and safeguards. Summer courses were established where many persons untrained in the practices of scientific procedure were in a few weeks turned out as Binet testers or "Bineters" as they were called. Spreading out over the country they advertised and sold their wares as though they were medical panaceas. Outraged parents, disillusioned school principals, social workers and academic psychologists protested loudly and the counter attack put the whole testing movement in jeopardy. Fortunately, science, rather than emotion, won the day; and when the Stanford Revision of the Binet-Simon Test appeared in 1916, with full instructions for giving the test and wise precautions to prevent the more common errors, keen observers realized that mental tests had come to stay, and that by constant study of results, improvement of methods and the training of efficient testers, the good results of testing might be preserved and the bad results largely eliminated. In many colleges full semester courses in testing were established, and in some of them a full year of experimental work in a psychological laboratory was made a prerequisite for the testing courses.

Achievement tests might have had a similar history except for the "horrible example" of the Binet test, and in schools where this history is not known, one now hears of teachers who, enthused with the many obvious advantages of objective tests in their own school subjects, have constructed and administered true-false, best answer or completion tests which have been so unsatisfactory that they have swung back in confusion to the old essay type of examination and condemned the whole testing movement. This paper is an attempt to prevent such disillusionment through a discussion of the main principles of good testing, and a display of the chief hazards in testing the blind.

As a considerable number of teachers in schools for the blind are now interested in giving group tests of intelligence and school achievement, it seems best to discuss, first, the basic principles for administering tests and then to indicate what tests are now available for use with the blind. After this the precautions necessary in adapting other standard tests for use with the blind will be described with examples of the good and bad results already obtained. The final section on the interpretation of tests is intended for two groups of teachers, those who plan to use tests already prepared for them, and those who prefer to make adaptations for themselves.

The general directions given in the World Book Company's manual for administering the New Stanford Achievement Tests cover the ground very adequately. These tests, it is said, "can be given satisfactorily by any teacher or principal who is willing to follow the directions in this manual conscientiously and who is reasonably skillful in discipline. The tester should possess a pleasing personality and be able to speak the necessary directions clearly and distinctly enough that every one in the test group may hear. . . . Good testing conditions demand that there should be quiet throughout the testing period. Strict obedience and attention on the part of the pupils are absolutely necessary. No questions should be permitted after the testing begins. There should be a spirit of rapport between the tester and the pupils. No visitors should be allowed. Sufficient assistants should be provided, when large groups are being tested, to see that everyone understands what he is to do and that he has the necessary materials with which to do it, and in order to discourage copying or giving assistance in any way.

"The person administering the test must speak distinctly and at a moderate speed. Undue stress and levity are to be avoided. An agreeable manner, but one suggestive of authority, is essential. Give all commands in a quick, energetic voice distinct enough for all those for whom it is intended, to hear. *Avoid shouting.* Give all directions slowly, with careful attention to emphasis where it is needed. *Follow the directions exactly.* Be watchful, and in so far as possible prevent disturbances within or without the room which might in any way interfere with the work of any pupil. Permit no whispering or copying. Distribute test booklets and administer the tests with dispatch. Systematize the work to avoid delay in administration. Adhere carefully to the time limits. A stop watch is desirable but not absolutely necessary. (The time limits are liberal. Probably many pupils will finish before time is called.) Plan your procedure in detail before attempting to administer the tests. Their administration is easy, but it is necessary to know exactly what to do at each moment of the testing time."

A considerable number of achievement tests are now available for use with the blind, and others are in preparation. A primary source is the writer's *Self-Surveys in Schools for the Blind,* published at the Pennsylvania Institution for the Instruction of the Blind in 1921. It contains tests in the fundamental operations of arithmetic and in arithmetical ingenuity, American history, English composition, English vocabulary, verbal ingenuity, sentence completion, word completion, geography, grammatical usage, silent reading, spelling, and rate of writing, based upon popular achievement tests of that period; besides two group intelligence tests, the Pressey Group Point Scale and the Pressey Cross-out Tests. To quote from the introduction: "The tests described in this Manual have been carefully adapted to the blind, used in from eight to ten schools upon about 450 pupils from the fourth grade upwards (by

1925 it had been used in ten schools upon more than 600 pupils), and revised to meet the friendly criticisms of the teachers who have seen them in operation. We believe that anyone who is intelligent enough to teach school, and who is sufficiently interested to study and follow the directions explicitly, can give these tests with a degree of exactness that will suffice for the usual problems of classification." Apparently we were somewhat ahead of the times for very little use seems to have been made of these tests. When the original issue of the Manual was exhausted, a new edition was considered but in view of the uncertainty of the response from teachers it was decided to bring out new tests from time to time in monograph form through the American Foundation for the Blind and later as articles in *The Teachers Forum.* Now that a considerable number of teachers are anxious to use objective tests, the time seems ripe for the revival of the tests in this Manual, for many of them are excellent tests and seem fairer to the blind than some of the more recent tests for the seeing, which involve mechanical processes very difficult to adapt to touch reading. Some of these tests can be given orally and so require no braille material; for the others, braille material will be provided through the American Printing House for the Blind.

As the general directions printed in the Manual contain various hints which will be valuable in all group testing of blind children, they are reproduced here. "That the results of the tests may be comparable with the published norms, the printed directions must be exactly followed, for a slight variation may make a test unexpectedly easier or more difficult. It will be best, therefore, to quote directly from this Manual when giving directions for the tests, using only the words printed in quotation marks. Teachers will find it a great help to try a test through with another teacher as a subject, before using the test in class.

In each test we have asked that the pupils write name, age, grade, and the date at the top of the sheet upon which they write their answers. This will make the test results much more valuable for later comparisons. If a stop watch is not available for use in the timed tests, teachers should always record on a slip of paper the time of starting each test, since it is very easy to lose track of the time if one is interrupted by a knock at the door or a question from the class. Pupils whose hearing is defective should be moved up close to the tester and all verbal directions should be spoken slowly and distinctly. So far as possible, the tests have been arranged so that they can be given orally to the blind, but where reading of test sheets is necessary, the blind are allowed from two to three times the period set for the seeing. No special preparation or coaching should be attempted before the giving of a standard test, nor any special stimulation applied when the test is given. Pupils should be allowed to write on braille slates, typewriters or mechanical writers according to their preference. No talking or whispering should be allowed, and interruptions and distractions of every sort should be prevented as far as possible. No help should be given in spelling; say, "Spell as well as you can." The mistakes made will be valuable evidence of the general spelling ability of the pupils. Backward pupils should not be prodded or helped further than is provided for in the printed directions. As soon as a test is completed, papers should be collected at once, to prevent later modifications, and special care should be taken to see that each pupil's name has been written as directed at the top of the sheet.

A second primary source with which teachers interested in testing the blind should be familiar is Dr. Kathryn E. Maxfield's *Adaptation of Educational Tests for Use with Blind Pupils*, published by the American Foundation for the Blind in 1927. Besides carefully arranging the reading and spelling tests of the 1927 Stanford Achievement Tests and the Gray Oral Reading Check Tests, she gave a valuable introductory section on the advantages of standard tests in schools for the blind, a very excellent discussion of questions suggested by the test results, and a section entitled "Miss West and Her Testing Program," which should be very helpful to any teacher in interpreting the results of tests used in her grade to the best advantage of the individual pupils. Braille sets of the Gray Oral Reading Check Tests are now available at the American Printing House for the Blind. The 1927 edition of the Stanford Achievement Tests has been superseded by the New Stanford Achievement Tests, published in five equivalent forms—V, W, X, Y and Z—for the seeing, and now accessible in all five forms for use with the blind. After a preliminary tryout at Perkins Institution by Dr. Maxfield in 1933-34, Form V was put into braille by Mr. Francis M. Andrews and used at Perkins in 1935-36; after this, a cooperative study was undertaken by the writer and the testers at Perkins Institution, the New York Institute for the Education of the Blind, and the Pennsylvania Institution for the Instruction of the Blind, and full directions for giving and scoring were published in *The Teachers Forum*, 1937, Vol. IX, No. 5. Braille material for these tests is now available at the American Printing House for the Blind, but before ordering the braille material, testers should order a sample set of inkprint material from the World Book Co.

The New Stanford Achievement Tests may be considered a third primary source of material for measuring progress in reading, spelling, language usage, literature, history and civics, geography, physiology and hygiene, and arithmetic reasoning and computation. Since there are five equivalent forms of the test, the braille pamphlets may be used as review material after testing, and another form of the test introduced the following year.

Additional tests now available for use with the blind and such printed reports as have so far appeared concerning them are as follows (before ordering braille material, testers should order a sample set of inkprint material from the appropriate publishers):

Monroe's Standardized Silent Reading Tests, published in three forms—Test I for grades 2-5, Test II for grades 6-8, and Test III for grades 9-12—by the Public School Publishing Co., Bloomington, Ill. Braille materials for Forms 1, 2, 3 are available at the American Printing House for the Blind. Directions for using the test with the blind may be found in *The Teachers Forum*, 1930, Vol. II, No. 5, in which Margaret Owen Thomas has an article on the adaptation of these tests. Class record sheets with keys for scoring and norms for the seeing may be obtained from the Public School Publishing Co.

Iowa Silent Reading Tests: Elementary Test, Form B, published by the World Book Co., Yonkers-on-Hudson, New York. Tests I-IV and VI adapted for use with the blind by Francis M. Andrews. Braille and directions are available at the American Printing House for the Blind. Key and class record sheets may be obtained from the World Book Co.

Wisconsin Inventory Tests in Arithmetic, published by the Public School Publishing Co. Given *orally* in six schools for the blind. Results reported by Dr. Frieda Kiefer Merry in *The Teachers Forum*, 1930, Vol. III, No. 2.

Stevenson Arithmetic Reading Test I, Form 2 (Problem Analysis), published by the Public School Publishing Co. Adapted for use with the blind by Dr. Frieda Kiefer Merry and used in six schools for the blind. Results reported in *The Teachers Forum*, 1931, Vol. III, No. 5.

Wilson Language Error Test I, comprising stories A, B, C, published by the World Book Co. Adapted for use with the blind by Dr. Frieda Kiefer Merry, used in grades three through six in two day school classes and eight schools for the blind. Results reported in the Perkins Publications, 1931, No. 10, "Motivating Language Lessons Among Blind Children in the Elementary Grades." Manual of directions, key and class record sheets may be obtained from the World Book Co.

Unit Scales of Attainment, Form A, tests of reading, geography, literature, American history, arithmetic (problems and fundamental operations) and English, published by the Educational Test Bureau, Minneapolis, Minn., Division 2, for Grades V and VI, adapted for use with the blind by Georgie Lee Abel, and results in sixteen schools for the blind reported in *The Teachers Forum*, 1938, Vol. X, No. 5. Braille material and pamphlet of directions for giving the tests are available at the American Printing House for the Blind. Key, class record sheets, and individual profile charts may be obtained from the Educational Test Bureau.

American Council Alpha Spanish Test, Form A, published by the World Book Co. Adapted for use with the blind by Dr. B. F. Holland and used in the Texas School for the Blind. Results and directions for use with the blind presented in *The Teachers Forum*, 1935, Vol. VIII, No. 1. Braille material is available at the American Printing House for the Blind. Key and class record sheets may be obtained from the World Book Co.

Sones-Harry High School Achievement Test, Forms A and B (for secondary schools and college entrance), tests of language and literature, mathematics, natural science and social studies, published by the World Book Co. Arranged for use with the blind by Georgie Lee Abel. Forms A and B in braille are available at the American Printing House for the Blind. Key and class record sheets may be obtained from the World Book Co.

New Stanford Achievement Test, Primary Examination, Form V, published by the World Book Co. Braille material and directions for using are available at the American Printing House for the Blind. Key and class record sheets may be obtained from the World Book Co.

Otis Classification Test, Form A, Part II, published by the World Book Co. Adapted for use with the blind by Miss Ruth Sargent with results at the Pennsylvania Institution for the Instruction of the Blind reported in *The Teachers Forum*, 1931, Vol. IV, No. 2. Results in another school were used by Hayes in *The Teachers Forum*, 1935, Vol. VII, No. 5, to show teachers "How to Handle Test Results." Holland, in *The Teachers Forum*, 1936, Vol. IX, No. 1, reported the results obtained through testing normal, blind, and deaf children. Braille material is available at the American Printing House for the Blind. Key and class record sheets may be obtained from the World Book Co.

Sangren Information Tests for Young Children, published by the World Book Co. Adapted for use with the blind by Hayes with directions for administering them in *The Teachers Forum*, 1938, Vol. XI, No. 2. No braille material needed.

Kuhlmann-Anderson Intelligence Tests, published by the Educational Test Bureau, Minneapolis, Minn. Adapted for use with the blind by Mrs. Ethel Nestell Fortner, tried out in three schools for the blind, and discussed in *The Teachers Forum*, 1939, Vol. XI, No. 3. Braille material and directions for giving and scoring are available at the American Printing House for the Blind.

The following section is intended for the assistance of teachers who may wish to adapt other objective tests for use with the blind, either for their own classes or as a minor research contribution to the repertory of tests now available.

1. What Standard Tests Shall We Use?

An enormous number of tests has been devised and published in the last twenty years and a number of centers for test distribution now publishes catalogues of tests and offers to sell specimen sets at a modest cost. If several teachers in a school are interested in testing, one of these portfolios makes an excellent school investment which may be kept in the principal's office or left with the school librarian for ready use by all of the teachers. Following is a list of well-known test publishers, with some indication of the prices of specimen tests and portfolios:

World Book Co., Yonkers-on-Hudson, New York
  Sample sets at 10-25¢ per test.
  Portfolio of Achievement Tests for Elementary Grades, $2.10. Samples of one form of 36 tests in the various subjects, with Manual and Key for each. Complete material for one test is included.
  Portfolio of Achievement Tests for High Schools and Colleges, $2.25. Samples of one form of 49 achievement tests in the various subjects. Complete material for one test is included, with Manuals for different subjects and different kinds of tests.
Cooperative Test Service of the American Council of Education, 15 Amsterdam Avenue, New York City
  Folio of Cooperative Tests for High School Students, $3.75. Samples of one form of each of 61 achievement tests for secondary school classes
  Folio of Cooperative English Tests (7 tests) $.75
  Folio of Cooperative Language Tests (18 tests) $1.50
  Folio of Cooperative Mathematics Tests (16 tests) $1.40
  Folio of Cooperative Science Tests (28 tests) $1.75
  Folio of Cooperative Social Studies Tests (16 tests) $1.50
  Booklet of 16 pages reproducing the directions and a selection of items showing the various types of questions used in recent forms of Cooperative tests, titled, "Cooperative Achievement Tests," price 25¢. This might well be owned by every school where tests are used.
Public School Publishing Co., Bloomington, Illinois
  File of elementary school tests (over 90 tests) $8.00
  File of high school and college tests (over 70 tests) $5.00
  Folios of tests in different subjects, $1.00 to $1.50

Other publishers of tests may be found by consulting the Mental Measurement Yearbooks published by Oscar K. Buros, Rutgers University Press, New Brunswick, N. J. Following are a few of those mentioned:

Bureau of Educational Measurements, Kansas State Teachers College, Emporia, Kansas
Bureau of Educational Research and Service, State University of Iowa, Iowa City, Iowa
Bureau of Publications, Teachers College, Columbia University, New York, N. Y.
California Test Bureau, 3636 Beverly Boulevard, Los Angeles, Calif.
Cooperative Bureau of Educational Research, 507 Mutual Bldg., Lansing, Mich.
Division of Educational Reference, Purdue University, Lafayette, Ind.
Ohio Scholarship Tests, State Department of Education, Columbus, Ohio
Psychological Corporation, 522 Fifth Avenue, New York, N. Y.
University of Minnesota Press, University of Minnesota, Minneapolis, Minn.

2. *What Special Precautions Must We Take to Make Sure That Our Adaptation Is a Fair and Reliable Measure of the Educational Achievement of Blind Pupils?*

Considering the mechanical difficulties of tactual reading and writing it is necessary to spend a little extra time accustoming blind children to the mechanics of testing. Arrangements of test items which are very easily understood with a glance of the eyes, even if a similar test has not been given before, may lead to confusion and misunderstanding when presented in braille. It is often important to give additional explanations and descriptions of material, followed by forepractice with sample items so that when the test really begins we shall be testing a child's educational achievement and not his quickness in adapting himself to a strange, new arrangement of braille material. Since blind children are given much of their regular instruction orally and are accustomed to the stricter attention and longer memory span involved in this method, one should consider the desirability of giving all of the tests orally, rather than slavishly duplicating the method used with the seeing. Of course there are dangers here: in an early attempt to give as much as possible of the Stanford Achievement series by having the tester read the material, it was discovered that children became unduly fatigued with long-continued braille writing and that some even developed blisters on their fingers from the intemperate use of the stylus. Even a spelling test may introduce hazards if testers come from different parts of the country from their pupils; so we have suggested in the directions for the Dictation Exercise of the New Stanford Achievement Test that, "If several teachers are to cooperate in giving this test, they should go over the words together and decide upon the pronunciations to be used, giving alternative pronunciations when the children do not seem to recognize a word." But the advantages gained by giving tests orally seem to the writer to outweigh the disadvantages in many cases, as indicated by the successful use of the oral method in the following tests in the writer's Self-Surveys Manual, and recent tests like them: Pressey's simple problems in oral arithmetic, Starch's Test of Grammatical Usage and Test 4, on Language Usage, in the New Stanford Achievement Test, the Starch dictionary spelling test and the Ayres spelling test, the Pressey rote memory, logical memory, opposites and analogies tests. The oral method should always be considered when adapting a series of tests for the blind, for besides the reasons already indicated, a change from continuous reading may reduce fatigue, and the oral method may effect a reduction in the total time needed for the tests. The English Usage test of the Unit Scales of Attainment as well as the Grammar, Language and History tests of the Otis-Orleans series might well be given orally, rather than in braille.

Certain types of tests are easily understood when presented to the fingers, others are very difficult and possibly unfair to the blind. The *multiple choice* technique seems readily grasped and has a play element which arouses interest. A number of the Stanford Achievement tests and the Unit Scales of Attainment are cast in this form, as are also the Otis Classification Test and many others. Another very good form is the *completion test* method, as illustrated in the Paragraph Meaning test of the Stanford Achievement series, Trabue's Language Scales, and the Pressey Word Completion Test presented in the Self-Surveys. The *matching technique,* used successfully with the seeing, causes various special difficulties, and needs considerable modification when used with the blind. This is the favorite method in the Sones-Harry High School Achievement Test, and is used several times in the Otis-Orleans Standard Graduation Examination, both of which contain a wealth of good test material. The ordinary arrangement is to have two parallel columns, one column consisting of a list of words or names and the other of a list of words, names or statements which should be associated with the former in the pupils' minds. For instance, we find in one of the tests on Language and Literature in the Sones-Harry series, a column of twenty names of American and English authors and a parallel column of fifteen titles of books or poems. The seeing pupil is to put after each title the number found in front of the author's name. A seeing pupil would look at the first title, *The Merchant of Venice,* and quickly skim the list of names until the eye was caught by "Shakespeare" which happens to be number 17; or he might glance rapidly up and down if he did not get the answer at once. A blind child might spend a good deal of time reading the column of names before he got his first answer, and would probably read slowly through the list for the names to go with the other titles until he gradually memorized the list. The process would thus be much slower and more tedious for the blind pupil and might be very discouraging if he had to give up on several items after repeated searching. It would seem to the writer a much better plan to transform at least half of the matching tests in the Sones-Harry series into multiple choice tests and, when the matching tests are used, to introduce each one by considerable explanation and forepractice. In this particular test the tester might first read the column of names aloud while the pupils read them silently so they would get some idea of the list to start with; then the first title might be used as a sample and worked through with the children.

True-false tests can easily be given to the blind, either orally or in braille. The first test in the Sones-Harry series illustrates this kind of test as does also the History Test in the Otis-Orleans series. These might be given orally, the tester reading the sentences to be judged and the pupils writing by means of their braille slates the number of the sentence and a single letter to indicate their decision as to whether the sentence is correct or faulty in expression, the only caution here being that the tester should select two letters for response which have the same number of braille dots, so that the sound of one child writing the answer could not help another. Teachers familiar with braille will at once think of "r" and "w" for right and wrong, "c" and "i" for correct and incorrect, perhaps "h" and "f" for honest and false.

Other interesting methods are illustrated in the Otis Classification Test and the Kuhlmann-Anderson Intelligence Tests. "Which of these five things does not belong with the others—potato, turnip, carrot, stone, onion? Which one of these five words means the opposite of strong—man, weak, small, short, thin? Which one of these five things is the smallest—twig, limb, bud, tree, branch?" These are samples from the Otis Classification Test; following are items from the Kuhlmann-Anderson Tests. "If these items were arranged in order what would be the *middle* one of the list: gallon, gill, bushel, quart, pint? What three things in this list *belong* together—dirt, iron, force, silver, wool, wire?"

Various special methods for saving time or reducing the number of errors will occur to ingenious test makers. In the Kuhlmann-Anderson adaptation, for instance, the children are frequently asked to write the first letter of the word chosen as an answer, thus saving the time and energy needed to write the whole word; in a test requiring them to rearrange a jumble of words to make a sentence, they are asked to record the first and last word, and not the whole sentence. In some reading tests it has been found convenient to have the children indicate how far they have read in a given time by rubbing down the braille dots, but most testers seem to find it more satisfactory to ask the children to keep their fingers on the last word until the tester can go about and mark the last word with a pencil. The same rubbing down method has been used in multiple choice tests, like tests 2, 5, 6, 7 and 8 of the Stanford Achievement series, on the ground that the children can hardly be expected to use a pencil as the seeing do. But if a short stub of a pencil is given to each child, his practice with a stylus seems to transfer to the use of the pencil, and little difficulty is experienced in its use. Also the pencil is less likely to damage the braille dots, which would render the test material useless for review work later on.

3. How Shall We Set the Time Limits of Our Tests so That They Will Test "Power" Rather Than Speed?

Obviously, if we are to compare the work of the blind with that of the seeing we must make reasonable provision for their slow rate of reading and writing braille. Preliminary experiments by the writer at the Pennsylvania Institution for the Instruction of the Blind, the results of which were published in 1918 as No. 1 of the Overbrook Monograph series, convinced him that blind children read only about one-third as fast and write with a stylus only about one-half as fast as seeing children having the same number of years' experience in school work. At first he attempted to set grade standards, but when he discovered that in some grades the fastest readers had a rate from three to five times that of the slowest, he sought another basis for comparison, with the following justification: "Seeing children begin school at the bottom, at about the same age, and progress with fair uniformity upward from year to year. In the large cities where the reading standards have been established, the backward are likely to be segregated in special classes, so that children in the grades are a relatively homogeneous group as to age, years of schooling, mental ability, etc. In a school for the blind, however, many grades are exceedingly heterogeneous. A child may begin school work with the substitution of fingers for eyes at six or at twenty. He may be quite undeveloped for his age through lack of opportunity or from native mental inferiority. . . . At Overbrook the children average from four to five years older than children in the same grades in the schools for the seeing. Again, there are no special classes for blind pupils of low mentality, and many are retained in schools for the blind because their discharge would mean the withdrawal of all educational advantages. And, of course, the handicap of blindness in general, and the difficulty of touch reading, prevent pupils of fair ability from attaining their proper place in school with the speed often observed with seeing pupils. For these various reasons it has seemed best not to rest content with a comparison of blind and seeing readers grade by grade, but to recast the figures in ways that would put the blind upon a more equitable basis." The basis decided upon was the number of years pupils had read braille, and tentative standards were set at about one-half the seeing rate in the early years and one-third the seeing rate in the later years, basing these standards on the actual attainments of the children at Overbrook. In planning tests for the Self-Surveys Manual of 1921, which were generally started with the fourth grade as the lowest grade in which one could successfully give tests in braille, about three times the time allowed the seeing was given to the blind. But, aside from the rate of straight-ahead reading we must consider the special difficulties encountered when a blind child must read from a braille pamphlet and then turn to a braille slate to record his answers to questions raised, with a considerable chance of losing time through mislaying or dropping his stylus or losing his place either in the braille pamphlet or on his slate. In many arithmetic tests, the Taylor arithmetic slate also must be used and the likelihood of losing time becomes still greater. Yet, in general, it seemed possible, when sufficient time was spent in orientation to the mechanics of the test and forepractice in its operation, for the blind to adjust themselves to the new testing techniques, and by gaining momentum with repetition, to finish the ordinary ten to twenty minute test in about three times the period allowed for the seeing. This was the allowance planned in the tests of the Self-Surveys Manual, and three times the seeing time has now become customary for a preliminary trial of other tests. Dr. Maxfield attempted a slight shortening of the time in her manual on the early form of the Stanford Achievement Tests and her method was criticized by Dr. Floyd F. Caldwell in a careful statistical study published in 1932 by the American Foundation for the Blind, entitled *A Comparison of Blind and Seeing Children in Certain Educational Abilities.* He correlated the results obtained by allowing blind children twenty, forty, fifty, sixty and seventy minutes on Forms A and B of Test 1; and ten, twenty, twenty-five, thirty, thirty-five and forty minutes on Forms A and B of Tests 2 and 3; the shortest times being the times allowed the seeing and the longest times being the periods needed by the slowest blind children and so considered the same as unlimited time on the tests. He found a regular rise in the correlations with the increase in time up to sixty minutes for Test 1 and to thirty-five minutes for Tests 2 and 3, with no advantage from a longer time allowance, i. e. he found that with thirty-five and sixty minutes respectively the blind did as well as though they had had unlimited time, so he set these intervals as the optimal time allowances for the blind in these tests and added further evidence to support our earlier recommendation of three times the seeing limits when testing the blind.

In the writer's directions for giving the revised forms of the New Standard Achievement Tests, a provision was made for determining the most advantageous time limits by experiment. Testers were requested to stop the children at the end of twenty-five minutes (in each of the tests for which seeing children are allowed ten minutes), and to go about the room and mark with a red pencil the last item worked on by each child. Then the test would be resumed for another ten minutes and the final item indicated by a black pencil mark, giving the extent of the child's work in twenty-five and in thirty-five minutes. Two schools have kindly reported the scores obtained at these two intervals, and the results of statistical treatment of the data are presented in the following tables. When the data were first turned in, an interesting and surprising fact emerged:

many pupils obtained a smaller score when allowed thirty-five minutes to work than they had obtained after twenty-five minutes, especially in the lower grades. The reason for this paradox appears to lie partly in the method of scoring a number of the tests, and partly in the fact that the test items tend to increase in difficulty from the beginning to the end of each subject division. In Test 4, Language Usage, for instance, *two* alternative answers are offered from which the pupil is to choose the one he prefers, and in order to limit success through mere guessing, the score is obtained by subtracting the number wrong from the number right. This method of scoring is based on the assumption that when a pupil makes a mistake he does not know the answer and is guessing, and that he may well be guessing on an equal number of items which he happens to mark right. In tests 5, 6, 7, and 8, *three* alternatives are offered, and the guessing element is nullified by subtracting one-half the number wrong from the number right. Now in all the tests the longer time interval made it possible for pupils to attempt the more difficult items farther along in the test, and in many cases there were more failures than successes. In tests 1, 2, 3, 9, and 10, which are scored according to the number right, a mistake would not reduce the score any more than an omission would, and in two of these, test 2, on word meaning and test 9, on arithmetical problems, an appreciable increase in average score was shown in many school grades; but in tests 4 through 8, a mistake is from 50 to 100 per cent worse than an omission, and an actual reduction in score was often found after the longer period of work. This in itself would seem to be a sufficient reason for favoring the shorter time limits in these tests, for obviously a considerable number of pupils had shown their maximal achievement in twenty-five minutes. But in order to give statistically valid reasons for settling the question, the following calculations were made.

The very high correlations shown in Table I in every test and in both schools indicate that so far as measuring the achievement of the pupils is concerned, it makes practically no difference whether the twenty-five or thirty-five minute in-

TABLE I. PEARSON'S PRODUCT MOMENT CORRELATIONS OF SCORES OBTAINED IN THE DIFFERENT TESTS OF THE NEW STANFORD ACHIEVEMENT SERIES WITH TWENTY-FIVE AND THIRTY-FIVE MINUTE INTERVALS FOR WORK

		School B Tested in Feb. '38			School C Tested in Feb. '38		
Tests	No.	No. of pupils tested	r	P.E.	No. of pupils tested	r	P.E.
Word Meaning	2	75	.99	.0016	73	.92	.012
Language Usage	4	75	.96	.0054	91	.89	.016
Literature	5	74	.97	.0047	93	.92	.011
History & Civics	6	74	.97	.0047	87	.92	.012
Geography	7	75	.98	.0031	92	.98	.0028
Physiology & Hygiene	8	75	.98	.0024	88	.99	.001
Arith. Reasoning	9	75	.98	.0034	56	.98	.0026
Arith. Computation	10	75	.99	.0009	No Records		

terval is used; the same pupils come to the top with either time allowance, and the same pupils are found at the bottom. A similar conclusion may be drawn from Table II, where correlations by *total* scores for the whole series of tests are presented.

TABLE II. PEARSON'S PRODUCT MOMENT CORRELATIONS OF TOTAL SCORES OBTAINED FROM THE TEN SUBJECT-DIVISIONS OF THE STANFORD ACHIEVEMENT TESTS IN TWO SCHOOLS TESTED IN FEBRUARY, 1938, WITH TWENTY-FIVE AND THIRTY-FIVE MINUTE INTERVALS FOR WORK

	Number of pupils tested	Correlation	P.E.
School B	74	.93	.0106
School C	94	.97	.004

In School A, a thirty minute time interval was allowed in the tests given in October, 1937, so correlations were made with the results in 1935 and 1936 when thirty-five minutes were allowed. To complete Table III the results in 1935 and 1936 were also correlated with each other. All three of these correlations are very high, thus adding further evidence to our conclusion that it does not make much difference which time limit is set and that we may as well save the extra ten minutes of teacher time and pupil fatigue in the testing program.

TABLE III. PEARSON'S PRODUCT MOMENT CORRELATIONS OF TOTAL SCORES OBTAINED FROM THE TEN SUBJECT-DIVISIONS OF THE NEW STANFORD ACHIEVEMENT TESTS IN SCHOOL A TESTED AT DIFFERENT DATES AND WITH VARIED TIME ALLOWANCES

Date and time allowance	Number of pupils	r	P.E.
Nov. 1935 (35 min.) and Dec. 1936 (35 min.)	69	.93	.011
Nov. 1935 (35 min.) and Oct. 1937 (30 min.)	40	.87	.027
Dec. 1936 (35 min.) and Oct. 1937 (30 min.)	45	.96	.007

A further statistical procedure commonly used in evaluating the results of tests is the calculation of the critical ratio, the quotient of the difference between two averages divided by the standard deviation of this difference. When this critical ratio amounts to 3 or over, the averages are regarded as showing statistically significant differences; as the ratio decreases,

TABLE IV. CRITICAL RATIOS FOR TESTS IN THE NEW STANFORD ACHIEVEMENT SERIES, FOR TWO SCHOOLS REPORTING RESULTS AT TWENTY-FIVE AND THIRTY-FIVE MINUTES

	School B tested in Feb. 1938							
	Means		S. D. of distrib.		S. D. of mean			
Test	25 min.	35 min.	25 min.	35 min.	25 min.	35 min.	Diff. of means	Critical ratio
2	85.36	90.58	20.94	19.86	2.42	2.29	5.22	1.57
4	89.36	89.92	24.16	26.08	2.79	3.01	.56	.14
5	90.72	91.63	17.64	18.55	2.05	2.15	.91	.31
6	85.7	88.8	24.6	25.3	2.86	2.94	3.10	.76
7	97.69	100.09	25.06	23.94	2.89	2.76	2.40	.60
8	84.3	85.85	18.35	17.75	2.12	2.05	1.55	.52
9	80.70	85.25	22.33	23.80	2.58	2.75	4.55	1.20
10	77.74	77.68	21.06	20.88	2.43	2.41	—.06	—.02
	School C tested in Feb. 1938							
2	80.5	86.6	16.64	17.36	1.94	2.03	6.10	2.17
4	82.37	76.70	25.62	26.81	2.68	2.81	—5.67	—1.46
5	76.98	81.33	18.83	20.51	1.95	2.13	4.35	1.50
6	81.46	85.24	18.76	21.28	2.01	2.28	3.78	1.24
7	87.8	89.3	19.8	20.4	2.06	2.13	1.50	.51
8	77.96	79.70	16.2	16.2	1.73	1.73	1.74	.71
9	80.12	83.54	18.72	21.24	2.50	2.84	3.42	.90

the differences between the averages become less and less reliable. The following two tables give the data leading to the critical ratios for each test in two schools and for certain comparisons in terms of total scores.

It will be observed that none of the critical ratios in Tables IV and V approximate 3, and that many of them are very low, two even becoming negative in two tests where the mean score at thirty-five minutes was actually less than the mean score at twenty-five minutes. These low critical ratios indicate that in none of these tests is there a significant difference in the attainment at thirty-five minutes, and therefore no reason for continuing to use the longer time interval. Our statistics then, both the correlations and the critical ratios, support the common sense conclusion based on the observation that many children got lower scores when allowed a longer time to work.

TABLE V. CRITICAL RATIOS FOR TOTAL AND AVERAGE SCORES IN THE NEW STANFORD ACHIEVEMENT TESTS, FOR TWO SCHOOLS REPORTING RESULTS AT TWENTY-FIVE AND THIRTY-FIVE MINUTES

	Means		S. D. of distrib.		S. D. of mean		Diff. of means	Critical ratio
	25 min.	35 min.	25 min.	35 min.	25 min.	35 min.		
School B								
Total	864.85	879.75	203.66	204.88	23.67	23.81	14.90	.44
School C								
Average	79.04	80.06	17.28	16.80	1.78	1.73	1.02	.41

In contrast to the low critical ratios obtained above we are presenting in Table VI some similar data resulting from retesting in School A. In this table we find critical ratios large enough to indicate significant differences; in this case they point to the progress pupils may make during a time interval on tests of this sort. This table shows that the average total score of the sixty-nine pupils tested in 1935 and again in 1936 rose from 683.6 to 808.4, obviously a good gain in achievement, and certified as significant by a critical ratio of 3.75. Almost as good a gain was made by the forty-five pupils tested in 1936 and 1937, while a much larger gain was made by the forty pupils tested in 1935 and 1937, with a critical ratio of 6.10.

TABLE VI. CRITICAL RATIOS FOR TOTAL SCORES IN THE NEW STANFORD ACHIEVEMENT TESTS OBTAINED BY RETESTING PUPILS IN SCHOOL A FOR THREE YEARS

Number of pupils	Means		S. D. of distr.		S. D. of mean		Diff. in means	Crit. ratio
	1935	*1936*	*1935*	*1936*	*1935*	*1936*		
69	683.6	808.4	186	204	24.55	22.38	124.8	3.75
	1936	*1937*	*1936*	*1937*	*1936*	*1937*		
45	780	887.6	180	156	26.82	23.25	107.6	3.03
	1935	*1937*	*1935*	*1937*	*1935*	*1937*		
40	663	899	148	194.4	30.76	23.42	236	6.10

SUMMARY

This chapter is an attempt to protect teachers in schools for the blind from falling into the more common errors made in mental testing. After a discussion of the basic principles and the most acceptable techniques of testing in general, a survey has been made of the best group tests which have been adapted for use with the blind, most of which are available on school quotas at the American Printing House for the Blind. The second section of the paper is intended to assist teachers who wish to adapt additional tests and use them with blind pupils. "What standard tests shall we use?" is answered by a list of test publishers and some of their offerings. "What special precautions shall we take?" leads to a detailed treatment of the technique of testing the blind. The final part of the paper is an extended discussion of the timing of tests used with the blind, presenting abundant experimental data which is statistically treated. This leads to the conclusion that in group tests blind children should be allowed approximately three times as long as the seeing to complete a standardized test involving the reading of braille with the possibility of some shortening of this allowance after the children have become accustomed to the special technique involved.

XV

Standard Graduation Examination for Elementary Schools:

Adapted for Use in Schools for the Blind

COMPLETION of elementary school work, with graduation from the eighth grade, marks an important milestone in a child's educational progress. How can we be sure that Johnny and Mary have thoroughly covered the elementary school subjects, that they have obtained the fund of information and developed the skills needed for success in the high school? Grade examinations written by the teacher who has taught Johnny and Mary may be discriminating and comprehensive; but they may reflect the educational limitations of the particular textbooks used or the cultural preferences of their teacher. The standard examination is an attempt at the objective measurement of educational attainment based upon the content of many textbooks, with standards obtained through the use of the tests with thousands of pupils.

This chapter presents an adaptation for use in schools for the blind of the Standard Graduation Examination developed by Dr. Arthur S. Otis and Dr. J. S. Orleans, published in five equivalent forms—A, B, C, D and E—by the World Book Co., Yonkers-on-Hudson, New York. Testers should write to the publishers for a specimen set for Form A, which consists of an inkprint copy of the test, a key for scoring, a class record sheet, distribution tables, and a manual of directions. It will be found most convenient to fill in the correct answers in the inkprint test booklet, which may then be used in correcting the papers of the blind pupils.

In the manual of directions will be found an interesting description of the derivation of this examination, the directions for the scoring of the tests and the treatment of the results. Directions for giving the tests to blind children make up the body of this chapter. Tests 1, 3, 6, 7, 8 and 9 are to be given orally to save the time and fatigue involved in extensive tactual reading. The braille materials for tests 2, 4, 5 and 10 of Form A, should be ordered from the American Printing House for the Blind, Louisville, Kentucky, and the cost may be charged against school quotas. Directions and braille copy for Forms B, C, D and E will be prepared as soon as there is a demand for them.

The main changes involved in adapting these tests for use with the blind are as follows: (1) The multiple choice technique has been substituted for the matching technique in tests 3, 8, and a part of 10, because the matching technique offers special difficulties to tactual readers as explained in Chapter XIV. (2) Six of the tests are to be given orally instead of only one, as when used with the seeing. This should somewhat reduce the testing time; it will certainly greatly reduce fatigue and will make it possible to test the pupils' spelling, vocabulary, grammar, language usage, and knowledge of literature and history, whether or not they are proficient in reading. (3) We have omitted certain items in arithmetic computation and in the use of diagrams and maps which do not seem fair to the blind and have divided test 5, "Arithmetic Reasoning," into two parts, printing the odd-numbered items as Part I and the even-numbered items as Part II. Testers may decide whether they can spare the time needed for both parts, or had better give only one of them. We have had no opportunity to determine whether Parts I and II are equal in difficulty. Of course these changes may make it impossible to compare our results with the norms for the seeing in some of these tests. It is suggested that for the present, until enough schools have reported their results for the establishment of standards for the blind, the 50 percentile norms for the seeing presented on page 9 of the manual of directions be taken as standards for the blind. As the seeing norms for Form A are based on the scores obtained from 23,000 pupils in thirty-five states, we have a fairly reliable criterion for comparison.

TABLE I. SUMMARY OF TIME LIMITS FOR THE OTIS-ORLEANS STANDARD GRADUATION EXAMINATION

Test no.	Test name	Time limits for seeing	Tentative limits for the blind
1	Spelling		Oral (20-25 min.)
2	Reading	20 min.	50-60 min.
3	Vocabulary	5 min.	Oral (10-15 min.)
4	Arithmetic computation (5 problems omitted)	20-25 min.	50-60 min.
5	Arithmetic reasoning	30 min.	Part I (35-45) first day Part II (35-45) second day
6	Grammar	10 min.	Oral (20-30 min.)
7	Language usage	10 min.	Oral (20-30 min.)
8	Literature	15 min.	Oral (35-40 min.)
9	History	20 min.	Oral (50-60 min.)
10	Geography	20 min.	50-60 min.

TABLE II. SUGGESTED PLAN FOR A SERIES OF EIGHT OR NINE SITTINGS

	Test	Testing time
a.	Reading	50-60 min.
b.	Spelling and grammar	Oral (20 min. for each)
c.	Arithmetic computation	50-60 min.
d.	Vocabulary and language usage	Oral (30-40 min.)
e.	Arithmetic reasoning Part I	35-45 min.
f.	Arithmetic reasoning Part II (may be omitted)	35-45 min.
g.	Literature	Oral (35-40 min.)
h.	History	Oral (50-60 min.)
i.	Geography	50-60 min.

DIRECTIONS FOR GIVING THE OTIS-ORLEANS STANDARD GRADUATION EXAMINATION FOR ELEMENTARY SCHOOLS, FORM A

In order to set standards for the blind, it is necessary that these directions be followed *verbatim.* It is strongly recommended that all testers *read* the directions printed in quotation marks to insure uniform procedure. The same directions may be used for Forms B, C, D and E, with slight variations for the different content in tests 2, 3, 7 and 8.

Certain modifications of technique may be desirable to meet local needs. For instance, typewriters may be substituted for braille slates in classes where sufficient facility has been developed and the supply of machines is adequate for the group being tested. Arithmetic slates are employed in some schools more commonly than in others; we have planned to have them used when it is the local custom to do so. In all group testing we recognize the possibility that differences in ability to read braille may cover up differences in knowledge of the context, and so have recommended oral testing when this accords more nearly with local classroom procedure. However, one must not use the oral method when so many items must be held in memory for comparison and discrimination that mistakes will result from too great stretching of the memory span. We have arranged to have tests 1, 3, 6, 8, and 9 given orally; possibly test 10 also might be given orally, though we cannot recommend this without trial.

Test 1. Spelling. (Oral)

"Today we are starting a series of interesting tests which will give you a chance to show how much you have learned.

"The first test is a spelling test. Get out your braille slates, put in a sheet of paper and write your name, your date of birth, and the present date at the top of the sheet. (If pupils can use typewriters accurately they should be encouraged to do so. Much time will be saved in scoring their work, but care must be used in distinguishing typing errors from spelling errors.)

There will be twenty-four words. I shall pronounce a word, then give a sentence in which the word is used, and then say the word again; then you are to write it. Use a new line for each word."

In pronouncing these words and sentences, be sure to speak very distinctly and loudly enough to be heard by all, so that there need be no occasion for repeating a word other than as shown in the list. However, do not suggest the spelling of a word by distorting its pronunciation. For example, in pronouncing such a word as "mental" the tester should be careful to pronounce it as if it were spelled "mentl." Any attempt to give an "a" sound in the second syllable would give undue help to the pupils. Take special care to pronounce all the words as naturally as possible. If several teachers are to co-operate in giving this test, they should go over the words together beforehand, and decide upon the pronunciations to be used, giving an alternative pronunciation when the children do not seem to recognize a word. When the more difficult sentences are reached, it is well to encourage the children with such expressions as, "Do the very best you can, even if you are not able to spell *all* these words."

Items for Test 1. Spelling

establish	They will *establish* a bank.	establish
ninety	He was *ninety* years old.	ninety
meant	He *meant* to do it.	meant
citizen	He is a *citizen* of the United States.	citizen
regularly	He exercises *regularly*.	regularly
insurance	An *insurance* policy.	insurance
existing	He studied the *existing* conditions.	existing
response	He gave an immediate *response*.	response
probably	He will *probably* be there.	probably
assurance	He gave us his *assurance*.	assurance
original	She was the *original* owner.	original
annual	An *annual* meeting is held.	annual
altogether	It is *altogether* too cold.	altogether
registered	The letter was *registered*.	registered
successful	He is a *successful* business man.	successful

literature	The book is about reading and *literature.*	literature
crocheting	She is *crocheting* a sweater.	crocheting
evidently	He *evidently* enjoyed it.	evidently
cordially	He answered very *cordially.*	cordially
exceptionally	It is *exceptionally* warm.	exceptionally
inconvenience	The rain caused much *inconvenience.*	inconvenience
guaranteed	The watch was *guaranteed.*	guaranteed
accredited	It is an *accredited* high school.	accredited
anniversary	It is their wedding *anniversary.*	anniversary

When collecting the papers make sure that each pupil has written his name at the top of the sheet. The score on this test is the number of words spelled correctly. Special rules for correcting the test are given on page 5 of the manual of directions.

Test 2. Reading. (50-60 minutes)

"This is a test to show how well you can read braille. I will hand each of you a copy of a pamphlet in which you will find five interesting paragraphs marked A, B, C, D, E, and under each paragraph a set of five questions upon what you have just read. Please do not look into the pamphlet until I tell you to do so. Get out your braille slates (or prepare your typewriters), put in a piece of paper, and write your name and the date at the top of the sheet. Then please fold your hands and keep them folded until I give you the signal to start."

Place one pamphlet on each desk and say: "Now listen carefully and do just what I tell you to do. Do not begin until I say 'GO.' The very second I say 'STOP,' you must stop work and hold up your stylus. After we have begun you *must not* ask any questions. If you drop your stylus, lose your place or need more paper, raise your hand and I will help you. Do your best and do not pay any attention to what anyone else is doing.

"Now open your pamphlets to Test 2, 'Reading,' and find the first paragraph, headed with a capital A. Keep your finger on the capital A while I complete the directions. You are to read this paragraph, consider the five questions under it and write answers to these questions on your braille slates (or typewriters), using as few words as possible. Try to give each answer in a single word if you can. A sample question is answered for you. First write the number of a question and then your answer. Use a new line for each answer. You may re-read the paragraph but should not waste time re-reading any more than is necessary to answer the questions.

"As soon as you have answered the questions on paragraph A, go on to paragraph B, then to C, D and E. I will tell you when to stop work on the test. Does everyone understand?" Allow time for further explanations, if needed, and then say: "Ready—GO." Record the exact time of starting.

At the end of fifty minutes say: "All stop for a minute, as I want to mark your work to show how far you have gone already. Please keep your finger over the last answer you have written to help me find it. Do not read any more until I tell you to do so." Go around with a *red* pencil and underscore the last word written on the braille slates (or typewriters). Allow a brief interval and then say: "Now find the place where you stopped work and wait for a signal to begin again." Then say: "You have ten minutes more for this test. Go ahead until I say 'STOP.' " At the end of this ten minutes collect all papers, making sure that each has a pupil's name at the top.

Seeing pupils are allowed twenty minutes for this test. According to our experience the blind require from two and one-half to three times as long for such work. The two scores obtained from the work done in fifty and sixty minutes will make it possible for us to set a standard time for the blind. The score in this test is the number of correct answers recorded by a pupil.

Test 3. Vocabulary. (Oral)

"This is a test of your knowledge of words. Please get out your braille slates (or prepare your typewriters), put in a sheet of paper and write your name and the present date at the top of the sheet." Allow time for this and then say: "I shall read to you a number of incomplete sentences; each sentence needs one word to make it true. After reading a sentence I will give you a list of five words from which you will select the one which you think is correct. Then you will write the number of the sentence and the word you select to complete the sentence on your slates (or typewriters). Use a new line for each answer.

"Before beginning the test we will try a couple of samples. 'Pretty means——cute, blond, good-looking, intelligent, rich.' (Read the sentence twice.) Now of course the best answer is 'good-looking.' Try another sample. 'To select means to——choose, throw away, postpone, criticize, love.' (Read the sentence twice.) Here the best answer is 'to choose.'

"Now we are ready for the test. I will give the number of a sentence and then read it twice so you will have a good chance to hear and remember all I say. You will select the word you prefer to complete the sentence and then write the number of the sentence and the word you prefer on your braille slates (or typewriters). Does everyone understand?"

Items for Test 3. Vocabulary

1.	To navigate means to	steer, float, dive, swim, fly.
2.	Hockey is	a school subject, a city, a game, a man, a book.
3.	Data means	knowledge, information, situation, daddy, instrument.
4.	A candid person is	deceitful, kind, pretty, frank, funny.
5.	To imperil means to	help, fasten, endanger, celebrate, imply.
6.	To envelop is to	write a letter, wrap up, fold, untie, seal.
7.	A battalion is	a battle, a gun, a vegetable, a fort, a group of soldiers.
8.	To absorb is to	take up, soak, heal, dry, eat.
9.	A festivity is a	holiday, game, dance, celebration, parade.
10.	Garlic is a	fruit, meat, vegetable, town in Italy, fish.
11.	Jubilant means	peaceful, joyful, sorrowful, lovely, wonderful.
12.	The word maternity refers to	sisterhood, fatherhood, a monk, motherhood, boys.

13. To refund means to take away, begin, repeat, finish, give back.
14. A lavatory is a bottle, volcano, washbowl, mountain, faucet.
15. Perjury means stealing, bankruptcy, false swearing, crying, profanity.

Read each sentence twice, slowly, being careful not to accent the correct response. If any pupils start writing before the second reading caution them to wait, to avoid confusion.

When collecting the papers be sure that a name appears at the top of each. The score on this test is the number of correct answers recorded by a pupil.

Test 4. Arithmetic Computation. (50-60 minutes)

"Today we have a test to show how well you can do examples in arithmetic. Get out your arithmetic slates and your braille slates (or prepare your typewriters), put in a piece of paper and write your name and the date at the top. I will pass the test pamphlets, but please do not look into them until I tell you to do so." Pass the pamphlets and then say: "In these test pamphlets you will find a series of examples with the number of each example printed before it in parentheses. In the first four examples you will be told what to do—whether to add, subtract, multiply or divide. Reduce all improper fractions to whole numbers and all fractions to their lowest terms. You can probably do some of the examples in your head. Use your arithmetic slates whenever you wish to do so.

"After solving an example write the number of the example and your answer on your braille slates, using a new line for every second example and arranging the answers in two columns on the paper, one down one side and the other down the middle. (If pupils prefer they may use one column and have extra paper.) If you come to an example you cannot do, write the number of the example, leave a blank space and go on to the next one. Does everyone understand?" Allow time for questions, and then say: "If you drop your stylus, lose your place, or need more paper, raise your hand and I will help you. Ready, GO." Record the exact time of starting. At the end of fifty minutes say: "All stop for a minute, as I want to mark your work to show how far you have gone. Please keep your finger over the last answer you have written to help me find it. Do not read any more until I tell you to do so." Go around with a *red* pencil and underline the last answer on the braille or typed sheets. Then say: "Now find the last example you were working on but wait for a signal to begin again." Allow a brief interval and then say: "You have ten minutes more. Go ahead until I tell you to stop."

At the end of this ten minutes say: "All stop," and collect the papers, seeing that each pupil has written his name at the top.

Seeing pupils are allowed twenty-five minutes for the twenty-five examples given them in this test. We have omitted five of these examples which do not seem fair to the blind and set the time limits at two and a half and three times the twenty minutes which would be allowed seeing pupils for twenty examples.

The score on this test is the number of correct answers reported.

Test 5. Arithmetic Reasoning. (Part I, 35-45 min. Part II, 35-45 min.)

"Today we are to have a test to show how well you can do problems in arithmetic. Get out your arithmetic slates and your braille slates (or typewriters), put in a piece of paper and write your name and the date at the top. I will pass the test pamphlets, but please do not look into them until I tell you to do so." Pass the pamphlets and then say: "In these pamphlets you will find a series of problems which you are to solve. You are to write the *number* of a problem and your *answer* on your braille slates (or typewriters). Use a new line for each problem. If you come to a problem you cannot solve, write its number, leave a blank space and go on to the next one. You will find that you can do some of these problems in your head, but you are free to use your arithmetic slates whenever you wish to do so. Does everyone understand?" Allow time for questions and then say: "If you drop your stylus, lose your place, or need more paper, raise your hand and I will help you. Ready, GO." Record the exact time of starting.

At the end of thirty-five minutes say: "All stop for a minute as I want to mark your work to show how far you have gone already. Please keep your finger over the last answer you have written to help me find it. Do not do any more work until I tell you to do so." Go around with a *red* pencil and underscore the last answer written on the braille slates (or typewriters). Allow a brief interval and then say: "Now find the place where you stopped work and wait for a signal to begin. You will have ten minutes more for this test. Go ahead until I tell you to stop." At the end of these ten minutes collect all papers, making sure that each one has a pupil's name at the top.

Seeing pupils are allowed thirty minutes for the whole test in arithmetic reasoning and if the blind are to be allowed from two and a half to three times the seeing time allowance, a second session for this test would be required, with the easier items the first day and the later, more difficult items at the second sitting. To meet this difficulty, Test 5 has been divided into two parts by printing the odd-numbered items as Part I and the even-numbered items as Part II. If testing time is limited only one part need be given. When a group is assembled for Part II, the same directions should be repeated.

The score on this test is the number of problems answered correctly. If only one part is given this score should be multiplied by two before the results can be compared with the standards for the seeing.

Test 6. Grammar. (Oral)

"Today we are to have a test to show how well you understand English grammar. Please get out your braille slates (or prepare your typewriters), put in a sheet of paper and write your name and the present date at the top of the sheet." Allow time for this and then say: "I shall read to you a series of numbered questions. You will write the number of the question and your answer on your braille slates (or typewriters). Use a new line for each answer. Let us take a sample sentence. I might say: Which word in the following sentence is a noun? 'The brave boy refused to run away.' The correct answer of course is 'boy,' so you should select that and write it on your slates.

"Now we are ready for the test. I will give the number of a question and then read it twice so you will have a good chance to hear and remember all I say. You will decide upon your answer and then write the number of the question and your answer on your braille slates (or typewriters). Does everyone understand?"

Read each question twice, slowly, being careful not to accent the correct response. If any pupils start writing before the second reading, caution them to wait to avoid confusion.

When collecting the papers be sure that a name appears at the top of each. The score on this test is the number of questions answered correctly.

Items for Test 6. Grammar

1. Which word in the following sentence is a pronoun? *He walks daily in the garden.*
2. Which word is a preposition? *He walks daily in the garden.*
3. Which word is an adverb?
4. Which word is a verb?
5. What is the masculine word corresponding to *mother*?
6. What is the singular of *feet*?
7. The pronoun *they* refers to what person (first, second, third)?
8. What word indicates the nominative case of the pronoun *my*?
9. What is the present tense of *went*?
10. What is the comparative of *large*?
11. What is the present participle of *live*?
12. The expression *in the blue suit* in the following sentence is called a what? *The man in the blue suit is the one who sold our car.*
13. The expression *who sold our car* is called a what?
14. What is the predicate of the sentence: *The roof over the back of the garage leaks*?

15. Which of these sentences is declarative (the first, second, or third)? 1. *Dogs bark.* 2. *Who is he?* 3. *How cold it is!*

16. Which of the five verbs following is a regular verb (declined regularly)? *go, have, see, keep, love.*

17. In the sentence, *He gave her a present,* what word is the direct object of the verb?

18. In the sentence, *The owner of the automobile that was damaged was in a store*, what is the antecedent of *that*?

19. In the sentence, *He brought the book home,* the verb is used in what voice?

20. In the sentence, *She found the purse where she had left it,* the clause is called what kind of a clause? *adjective, noun, adverbial, independent.*

Test 7. Language Usage. (Oral)

"Today we will have an interesting test to show how well you can supply the correct word in a simple sentence. I shall read you a series of numbered sentences each with a missing word or two which I shall indicate by the word 'blank.' You will think what would make the sentence correct and sensible and then write the number of the sentence and your word or words on your braille slates (or typewriters). For instance, I might say 'How—blank—brothers have you?' You would probably say 'many,' for 'How many brothers have you?' makes a sensible question, and you would write 'many' on your slates. Arrange your answers in two columns, one down the side and one down the middle. Does everyone understand?" Allow questions and then have the pupils put paper in their slates and write name and date at the top. When all ready, say: "Now we are ready for the test. Sentence 1. Dan and his brother—blank—going fishing yesterday. (Allow a slight pause before and after 'blank' each time it is used. Read each sentence twice to help the pupils remember it in detail.) Write the number 1 and the word you would supply on your slates (or typewriters), using a new line for each word." Allow a brief time for writing and then give another sentence.

At the end of the twenty-five sentences collect the papers, seeing that a name appears at the top of each. The score on this test is the number of correct answers reported.

Items for Test 7. Language Usage

1. Dan and his brother—blank—going fishing yesterday.

2. Each of the boys—blank—ready this morning with a new fishing rod.

3. Robert—blank—care so much about fishing as Dan does. Dan likes fishing very much.

4. I had my picture—blank—yesterday. The word begins with 't'.

5. I lay in the hammock all morning. While I was—blank—in the hammock, she called me. The word begins with 'l'.

6. Bill said, "I am going to go." Robert said, "If I—blank—in your place, I would stay at home."

7. Dan asked me to do a favor for him, and I—blank—it.

8. Joe and I are the same age, but he is taller than—blank—.

9. He can beat Ted or—blank—at almost any game we play with him.

10. "Only Ben and I are planning to go," said Dan. "Don't you want to come with Ben and—blank—?"

11. Dick said, "Let's fish in Foster's lake." I asked, "Won't he object to—blank—fishing in his lake?"

12. "Everyone has always fished in that lake whenever—blank—wanted to," said Tom.

13. As I was passing there yesterday, I—blank—him putting up a "No Trespassing" sign.

14. A variety of types of questions—blank—used in this test.

15. "No one but Mr. Jones—blank—self," I answered.

16. The boys hurried down the street, except Jack, who walked very—blank—and was soon far behind the rest.

17. Just then I saw the boys coming. I didn't expect them to have—blank—fish at all, but they had six.

18. Of the two sisters, Mary is by far the—blank—.

19. I can read most books very fast, but not—blank—kind. The word begins with 't'.

20. Mary—blank—going because her mother won't let her.

21. Blank—do you think was talking to Mabel yesterday?

22. Miss Jones, our singing teacher, was absent; so a substitute—blank—us how to sing today.

23. Blank—were you talking with?

24. There—blank—be scarcely any food left when we get there.

25. These books are mine; —blank—books are Dick's.

Test 8. Literature. (Oral)

"Today we are to have a test of your knowledge of literature. Please get out your braille slates (or prepare your typewriters), put in a sheet of paper and write your name and the present date at the top of the sheet." Allow time for this and then say: "I shall read to you a number of incomplete sentences; each sentence needs one word or phrase to make it true. After reading a sentence I shall give you a list of three words or phrases from which you will select the one which you think is correct. Then you will write the number of the sentence and the word or phrase you select on your braille slates (or typewriters). Use a new line for each answer.

"Before beginning the test we will try a sample sentence. 'Goldilocks appears in the same story as—the dwarfs, the bears, Brer Rabbit.' The words necessary to complete the sentence are 'the bears.'

"Now we are ready for the test. I will give the number of a sentence and then read it twice so you will have a good chance to hear and remember all I say. You will select the word or phrase you prefer to complete the sentence and then write the number of the sentence and the word or phrase you prefer on your braille slates (or typewriters). Does everyone understand?"

Read each sentence twice, slowly, being careful not to accent the correct response. If any pupils start writing before the second reading, caution them to wait, to avoid confusion.

When collecting the papers be sure that a name appears at the top of each. The score on this test is the number of correct answers reported.

Items for Test 8. Literature

1. Meg appears in the same story as: Alice, Amy, Eppie.
2. The Rabbit appears in the same story as: The Whale, Penrod, Alice.
3. Huckleberry Finn appears in the same story as: Kim, Tom Sawyer, Hans Brinker.
4. Jim Hawkins appears in the same story as: Long John Silver, Sindbad, Old Hildebrand.

5. Captain Hook appears in the same story as: Captain Kidd, Silas Marner, Peter Pan.

6. Portia appears in the same story as: Macbeth, Ophelia, Antonio.

7. Sam appears in the same story as: Eva, Penrod, Heidi.

8. Silas Marner appears in the same story as: Eppie, Mehitable, Joe.

9. Tiny Tim appears in the same story as: Scrooge, Beth, David Copperfield.

10. Hawkeye appears in the same story as: Old Hildebrand, Uncas, Tom Sawyer.

11. Topsy appears in the same story as: Sam, Eva, Elsie.

12. Robin Hood appears in the same story as: Alan-a-Dale, Lancelot, Sir Walter Raleigh.

13. Merlin appears in the same story as: King Lear, King John, King Arthur.

14. Goliath appears in the same story as: David, Joseph, Moses.

15. Gretel appears in the same story as: Jack and Jill, Ben Hur, Hans Brinker.

16. A story of early pioneer days in the West is: The Last of the Mohicans, Redskin, The Covered Wagon.

17. The story of a man who took care of his sister's children is: Seventeen, Helen's Babies, Now We Are Six.

18. The story of how some shipwrecked people lived on an island until rescued is: Robinson Crusoe, Swiss Family Robinson, The Ancient Mariner.

19. A story of the early days of Christianity in the Roman Empire is: Ben Hur, Abelard and Héloise, Hamlet.

20. A story about a white whale is: Kidnapped, Moby Dick, Captains Courageous.

21. A series of letters from a girl to a man who helped her is: Jane Eyre, The Poor Little Rich Girl, Daddy Long Legs.

22. A story of knighthood in England during the Middle Ages is: Ivanhoe, Oliver Twist, Don Quixote.

23. The adventures of a very wealthy boy and a very poor boy who changed places are found in a book called: Little Lord Fauntleroy, The Prince and the Pauper, Penrod and Sam.

24. The punishment of a man who committed what was considered to be a very serious offense is found in a story called: The Man Without a Country, Hiawatha, Sindbad the Sailor.

25. A play of Italy about a money lender who was punished for his greediness is: Two Gentlemen of Verona, As You Like It, The Merchant of Venice.

The tester will read this note before continuing: In the following ten tests the names from which you select your answer are printed at the *beginning* of each sentence.

26. Hamlet, Ichabod Crane, Jim Hawkins: was frightened by a horseman without a head.

27. Rip Van Winkle, Tony Lumpkin, Long John Silver: had a wooden leg.

28. Harvey Cheyne, Little Lord Fauntleroy, Tiny Tim: was traveling to Europe with his mother when he fell overboard.

29. Scheherazade, Titania, Wendy: was queen of the fairies.

30. Evangeline, Hester, Portia: found her lover dying.

31. John Alden, Governor Endicott, Miles Standish: was too bashful to ask Priscilla himself.

32. Jim Hawkins, Bill Sikes, Silas Marner: murdered his wife.

33. Ali Babi, Scheherazade, Simon Legree: told the stories of the Arabian nights.

34. Old Ironsides, Victory, Oceanic: was a ship famous in American history.

35. Venus, Helen, Delilah: ran away with Paris.

Test 9. History. (Oral)

"Today we will have a test to show how much you know about American history. I shall read to you a series of numbered statements which may be either correct or incorrect. You will listen to a statement, consider whether you agree with it or not and then on your braille slates (or typewriters) you will write the number of the statement and a single letter to indicate your opinion: a 'c' if you think the statement correct, an 'i' if you think it incorrect, or an 'e' for 'either' if you do not know whether it is correct or not. For instance, I might say, 'Andrew Jackson was the second president of the United States.' This, of course, is incorrect so you would write an 'i' to indicate this. If you did not know, you would write an 'e' for either, since the statement might be either correct or incorrect so far as you know. Does everyone understand?"

Allow questions and then say: "Put a sheet of paper in your braille slates (or typewriters), write your name and the date at the top and be ready for the test." When all are ready say: "Statement Number 1. 'When Columbus returned to Spain from his first voyage to America, he was greeted as the discoverer of a new continent.' Consider whether this is correct or incorrect, or might be either so far as you know, and then on your slates (or typewriters) write number '1' and a 'c' for correct, an 'i' for incorrect, or an 'e' for either, if you do not know. Write your answers across the page, leaving one cell blank after each answer." Allow a brief interval for writing and then give the other statements as printed below. Any statement may be repeated once if desired, but it does not seem necessary to read all the statements twice as has been done in some of the preceding tests. Pupils may be cautioned to give better attention to the first reading if they ask for too many repetitions.

The letters "c," "i" and "e" were chosen in preference to the "t" and "n" used by the seeing to indicate true and not true, because fewer dots are needed in writing these letters in braille. Also, the same number of dots occur in all three of the letters we have chosen so blind pupils can get no help from each other by noticing differences in the sounds of writing on their braille slates.

When the forty-eight statements have been given, collect the papers, making sure that a name appears at the top of each. In scoring this test, count the number of right responses, the number of wrong responses and the number of omissions, making sure that they add up to 48. Then subtract one half of the number wrong from the number right to get the score. This is the customary procedure to nullify the effect of pure guessing when three alternatives are given.

Items for Test 9. History

1. When Columbus returned to Spain from his first voyage to America, he was greeted as the discoverer of a new continent.
2. The settlement at Jamestown almost failed the first year be-

cause most of the settlers were unfit for the hardships they met with.

3. The Townshend Acts had to do with taxation and made the colonists more dissatisfied with England.

4. There were about three million persons in the colonies at the beginning of the Revolutionary War.

5. The United States Constitution was finally ratified by all the states except North Carolina and Rhode Island.

6. Lewis and Clark were sent by Jefferson to explore the northern part of the Louisiana Purchase territory and the Pacific Northwest.

7. By 1820 there were more than fifteen states in the Union.

8. When a family "moved West" in the early part of the nineteenth century, it first had to get permission to move and obtain a grant of land from the government.

9. A fast express train today, like the Twentieth Century Limited, travels just about twice as fast as the fastest train traveled in 1830.

10. Jackson, like the preceding six Presidents, was a cultured gentleman who came from a wealthy family.

11. Under the "spoils system," a man who was selected to an executive office discharged many of the less important government employees and gave their jobs to his friends and supporters.

12. At first the Abolitionists were opposed by the people in the North.

13. For a period of several years Congress unconstitutionally denied the right of petition concerning slavery.

14. England's claim to the Oregon Country was stronger than our claim because the Oregon Country had been settled almost entirely by English pioneers.

15. The reason for Perry's visit to Japan in 1853 was to gain some of the trade of that country which was going largely to England and France.

16. Many Germans and Scandinavians came to this country around 1850.

17. Since the earliest days of our country there has existed in every state a system of public schools for all children.

18. There was regular steamship service between America and Europe within five years after Fulton's *Clermont* made the trip from New York to Albany.

19. The invention of the sewing machine in 1846 made it possible to obtain clothing much cheaper than formerly.

20. Cooper was one of the first great American novelists.

21. By 1800 the educational opportunities for women in this country were equal to those for men and most colleges were open to both men and women.

22. Differences of opinion between the North and the South were due largely to a lack of understanding of each part of the country about the other part.

23. The use of slaves in the Northern factories after 1800 would have been very economical and would have become common, but the people of the North were opposed to slavery as being morally wrong.

24. Within a few years after 1849 the population of California increased from about 6,000 to over 50,000.

25. The Compromise of 1850 settled the slavery problem permanently.

26. Kansas and Nebraska were both admitted in 1854 (the date of the Kansas-Nebraska Act)—Kansas as a slave state, Nebraska as a free state.

27. Lincoln was elected in 1860 by a very big popular majority, which showed that the people in all parts of the country wanted to preserve the Union.

28. Until Grant was put in command of the Northern armies, the plans of the Northern generals had been only partly successful.

29. The battle of Gettysburg was Lee's last attempt to stop Grant on his way to Richmond.

30. When the Civil War was over, many of the freed negroes believed that work was the sign of slavery and that the government would support them.

31. The purchase of Alaska has been very well worth while to the United States.

32. The last state was admitted to the Union after 1900.

33. In spite of the fact that most of the Civil War was fought in the South, very little property was destroyed there and the South was fairly wealthy when the war was over.

34. The political parties have always agreed that there should be a high tariff.

35. The purpose of the direct primary is to reduce the power of the political boss in his party.

36. The "initiative" in government is a means by which voters can make laws without the legislature.

37. The first trust was organized in this country during the World War.

38. Samuel Gompers was a notable labor leader.

39. Chinese immigrants have always been welcomed because they work for such small wages.

40. Congress has passed laws limiting the number of immigrants that may enter the country partly because of the large number that have come and failed to become Americanized.

41. The sinking of the *Maine* was the immediate cause of the war with Spain in 1898, although it was not known then whether Spain was at fault.

42. The control of the Philippines by the United States followed upon the victory of the United States in the Spanish-American War.

43. Although at the close of the war in 1898 the United States agreed to the independence of Cuba, the United States has made several attempts to annex the island.

44. Although Canada and the United States have much the same historical background, they have been unfriendly most of the time during the last fifty years.

45. The *Lusitania* was an American battleship that was taking English citizens who had been living in the United States back to England, when it was torpedoed by a German submarine.

46. The number of persons that perished all together as a result of the World War was more than 4,000,000.

47. The Senate supported President Wilson's stand on the League of Nations, but the House of Representatives defeated him.

48. The efficiency of our government is shown by the fact that it has been free from official corruption or scandal since 1920.

Test 10. Geography

"This is a test of your knowledge of geography. You will not need braille slates but will be asked to draw lines through certain words on the test pages with a short pencil which I will give you. Please do not look at the test pages until I tell you to do so." Pass the test pamphlets and short, black lead pencils and say: "In this test you will find a series of sentences each of which needs a word, phrase or sentence to make it true. Following most of the sentences you will find a list of five words, phrases or sentences from which you are to select the correct ones; the last few sentences offer only three choices. When you have decided which will best finish the sentence you are to draw a line through your choice with your pencil.

"Open your pamphlets and find the sample statement at the beginning. This reads: 'The capital of France is—Versailles—Marseilles—Vienna—Paris—Bordeaux.' The correct answer of course is 'Paris' so you should draw a line through that name. Do not go on with the test until I give you the signal. Does everyone understand?" Allow questions and then say: "Now we are ready to begin the test. Do not start till I say *go*, and the very second I say *stop*, you must stop. After we have begun you must not ask any questions. If you drop your pencil, or lose your place, raise your hand and I will help you. If you come to a sentence you cannot do, skip it and go on to the next. Ready, *go*."

At the end of fifty minutes say: "All stop for a minute as I want to mark your work to show how far you have gone. Please keep your finger on the last thing you have marked to help me find it. Do not read any more until I tell you to do so." Go around with a *red* pencil and encircle the last word marked by each pupil. Then say: "Find the last sentence you worked on and wait for the signal to go on." Allow a brief interval for finding the place and then say: "You have ten minutes more for this test. Ready, *go*."

At the end of this ten minutes collect the pamphlets, writing each pupil's name at the top of the page he has been working on.

Seeing pupils are allowed twenty minutes for this test so we have arranged for the blind to have two and a half and three times as long, making it possible for us to collect data at fifty and sixty minutes. The score in this test is the number of correct responses.

XVI

Mental Measurements of the Blind: History, Inventory, Criticism

It is a surprise to many people to learn that there is any need for the application of mental measurements to blind children, and it is equally a matter of surprise that such measurements can be and have been made. In schools for the blind where small classes, full daily programs and the intimacy of social relations in dormitories offer unusual opportunities for teachers to become well acquainted with their pupils, one might assume that mental measurements would be superfluous; in fact this position is still held in some schools. But where teachers' judgments and standard measurements have been compared we find the same striking differences of opinion which have motivated the almost universal use of tests in schools for the seeing, and in grades which have been determined on the basis of teacher judgments alone enormous differences in ability are disclosed by tests. In such grades we are pretty sure to find children who simply cannot do the work, but have been retained by kindly and over-sympathetic teachers; and we often find children denied promotion because a teacher does not approve of their attitudes, because their work has been "spotty," or because they have not fulfilled her demands in all details, when standard tests show that they are ready for the next grade and may be seriously injured by repeating a whole year's work with little sense of achievement.

In some schools for the blind standard tests have now been used for nearly twenty-five years, and the test movement is rapidly extending to many others. The first adaptation of intelligence tests was attempted by R. B. Irwin and H. H. Goddard in 1914; the use of achievement tests was begun by S. P. Hayes in 1917. The primary object of both types of tests is to assist in the educational process, but certain distinctions should be made between them. The chief aim of intelligence tests is to determine the native capacity of children so that they may be scientifically classified in groups of similar ability, those who have very little ability may be segregated in special classes, and those with superior ability may be encouraged to attempt a more comprehensive and enriched course of study. Incidentally intelligence tests may suggest to the teacher plausible explanations of poor work or restlessness and give valuable hints for vocational guidance. Achievement tests are designed to show how well the children are doing their school work, and when compared with intelligence tests of the same children, serve to indicate whether the children are making reasonable use of their native abilities. Achievement tests are standardized by applying them to large numbers of pupils in different parts of the country, following explicitly the instructions for administering them. They therefore provide standards or norms with which to compare any individual, grade or school; and when given in successive years they measure progress and become valuable aids in the promotion and reclassification of pupils. In their latest development, as diagnostic tests, they facilitate the analysis of school subjects into their elements, thus showing the teacher which parts of a subject need special emphasis for individuals or a grade as a whole; and they may prove the need for changes in the time allotted to certain subjects or parts of subjects. Incidentally all achievement tests may become motivating devices since they arouse the interest of teachers, pupils, and parents. If a child of good native ability tests repeatedly well below average in a series of achievement tests, it is hard for him to find alibis, and the teacher is protected from the criticism of parents who cannot understand why their child is obliged to do so much home work.

A. Achievement Tests in Schools for the Blind

The first standard achievement test to be put into braille was a simple reading test. Reading seemed a natural subject for the first attempts at measurement because so large a part of school work depends upon facility and accuracy in handling braille; and the attainment of reasonable proficiency in reading during school days is fundamentally important for any adult who hopes to keep in touch with the world of people and events. The test selected was easily adapted for the blind and its use brought to our attention various facts which have been very important in our tests in other school subjects. Aside from the fact that it proved the possibility of using with blind children standard tests constructed for the seeing, it brought to light great differences in reading rate and in comprehension within grades and in groups selected according to years of school experience and mentality. It also showed that in general blind children read only about one third as fast as seeing children—a fact which has been of the greatest importance in the adaptation of all timed tests which must be given in braille. Other conclusions derived from this experiment were that one could not expect blind pupils below the fourth grade to be far enough advanced in reading to take group tests in braille; that standard tests might be expected to show wide individual variations in ability but little sex difference; that late entrance into schools for the blind and the slowness of braille reading might be expected to cause an age-grade retardation of two or more years; that comprehension in reading is correlated positively with general intelligence.

After this preliminary trial with reading, standard tests in other school subjects were adapted and, at the request of the Efficiency Committee of the American Association of Instructors of the Blind, used in a survey of eight to ten schools by trained testers from the Pennsylvania Institution for the Instruction of the Blind and from Perkins Institution. In 1921 the writer published his manual, *Self-Surveys in Schools for the Blind*, giving explicit directions for various tests.

The second decade of achievement testing in schools for the blind witnessed a slow but steady increase in interest. In 1927 Kathryn E. Maxfield published her *Adaptation of Educational Tests for Use with Blind Pupils* in which directions were given for administering the reading and spelling tests of the 1927

Stanford Achievement series and Gray's Oral Reading Check Tests; in 1927 the Experimental School was established at Perkins Institution in co-operation with the American Foundation for the Blind, providing a laboratory for testing the tests; in 1928 Dr. Maxfield published *The Blind Child and His Reading* and started the publication of *The Teachers Forum for Instructors of Blind Children,* opening its pages to descriptions of new tests and reports of their results; in 1931 Miss Lende, Librarian of the Foundation, started her reading lists with a bibliography of educational and mental test references. Just how many teachers began testing during this decade we do not know but a report of extensive testing at the California school was presented by Anita M. Mühl at the convention of the American Association of Instructors of the Blind held in California in 1930, and several new names appeared in connection with articles about tests in *The Teachers Forum,* Mrs. Thomas giving directions for the use of the Monroe Standardized Silent Reading Tests, R. V. Merry and Marion Kappes writing about the use of music tests and B. F. Holland reporting upon his experiments with braille reading and giving directions for the use of standardized tests for Spanish. During the same period the writer published three articles upon tests in *The Teachers Forum,* and presented a general review of his twenty years of research in schools for the blind at the Raleigh convention of the American Association of Instructors of the Blind, in 1936.

Our third decade of achievement testing, beginning in 1937, bids fair to be an era of flowering, marked first by the widespread use of a comprehensive series of tests arranged by the writer, and by the independent adaptation and use of various special tests by teachers and principals. After satisfactory preliminary trials of the former—the New Stanford Achievement Tests, third revision—the writer, in co-operation with testers in three eastern schools published detailed instructions for giving the whole series of tests: paragraph meaning, word meaning, spelling, language usage, literature, history and civics, geography, arithmetical reasoning and computation. Paragraph meaning is tested by asking the children to read a paragraph and supply a missing word intended to show whether or not they have understood it. For example, "Dick and Tom were playing ball in the field. Dick was throwing the ball and . . . . was trying to catch it." Word meaning was tested by asking the children to select the one out of five given words which best completes a sentence. For example, "A rose is a box flower home month river." Spelling is tested by dictating a series of sentences containing simple words for the lower grades, and progressively more difficult words for the higher grades. Language usage is tested by asking the children to decide which of two sentences is better. For example, "Apples *is* good." "Apples *are* good." Knowledge of literature is tested by asking the children to select from three alternatives the best word to complete a sentence. For example, "Little Red Riding Hood took cakes to her aunt cousin grandmother." The best-answer technique is used also for testing history and civics. For example, "The Pilgrims came from England France Spain." The same formula is used for testing geography. For example, "A state having no seacoast is Maryland Idaho South Carolina." To test physiology and hygiene also three alternative answers are offered. For example, "The body is covered by muscles bones skin." In testing arithmetical reasoning ordinary problems are used such as, "Charles has six brown rabbits and five white ones. How many rabbits has he?" Of course in all the tests, simple items are given at first to encourage the younger pupils; then the items become progressively more difficult, the later ones demanding years of schooling. The tests of arithmetical computation begin with simple exercises in addition, subtraction, etc., and rise to advanced problems in decimals, columns, areas and unknown quantities.

The Stanford Achievement Tests are issued in five equivalent forms which have been put into braille and made readily accessible to schools on quota from the American Printing House for the Blind. In at least one school all five forms of the test have been used, and at least a dozen schools have reported upon one or more testings.

These tests have given the teachers reliable pictures of their pupils' work, and where they have been repeated year after year, they have yielded illuminating curves showing the progress of individuals, grades and schools in most of the subjects taught in the elementary grades. In schools in which the children have been properly classified the curves based upon grade averages have shown the blind to be just about at the seeing levels, thus proving the possibility of normal educational progress by the blind and the feasibility of testing their progress with standard tools of measurement. Of course curves by chronological or mental age show the expected two or more years retardation, but this is inevitable since the achievement tests have a positive correlation of more than .80 with our adaptation of the Binet intelligence tests. Also these tests demonstrate the ability of blind children to adapt themselves to strange new ways of testing—they readily adjust themselves to the use of a short pencil to mark the amount of work they have done on the braille test when time is called, they quickly learn to deal with material put in best-answer, word-completion or true-false form. On the other hand they have a good deal of difficulty with matching tests since this technique involves quite a tax on the memory or very frequent rereadings. The ordinary arrangement, in this method of testing, is to print two parallel columns, one column consisting of a list of words or names and a second column consisting of items to be associated with them. The seeing pupil can readily look up and down the lists until he finds the items that match: for the blind it is a much slower process because he must read the whole of both lists and then either memorize one or go over it repeatedly, wasting time and probably making mistakes. So it has been our custom to transform inkprint matching tests into some other form, retaining the original content. It is also frequently a wise course to give a certain proportion of our test material orally: this saves much reading time and accords with the common emphasis upon oral teaching in schools for the blind.

To meet the demand for information as to what tests have been put into braille and therefore might be feasible for administration by interested teachers, we have listed below all the achievement tests adapted for use with the blind in recent years. Listing, however, does not imply recommendation. The writer has had no opportunity to observe the use of most of the tests in Sections II and III, but since the braille for most of these tests is accessible on quota at the American Printing House for the Blind, he hopes that many teachers will put it to use and give him a critical report of their findings. The American Printing House for the Blind will give information concerning the grade of braille used, the number of pages in each test pamphlet and the school grades for which the tests are suitable.

1. Achievement Tests for Elementary School Children

a. Tests in a single subject

Sangren Information Test for Young Children (Oral, no braille)
Gray Oral Reading Check Tests (Oral, no braille)
Monroe Silent Reading Tests—Forms 1, 2, 3
Iowa Silent Reading Tests: elementary—Form B
Pressey Test of Practical Information
Otis Classification Test—Form A, part 2 (Oral, with braille)
Hahn-Lackey Standardized Test of Geographical Information
Courtis Map Test
Michaelsohn American History Tests (Oral, no braille)
Wisconsin Inventory Tests in Arithmetic
Stevenson Arithmetic Reading Test I, Form 2
Wilson Language Error Test I
Mitchell Testbook for Caldwell and Curtis "Introduction to Science"

b. Test series covering most of the school subjects

New Stanford Achievement Tests: advanced examination—Forms V, W, X, Y, Z
Unit Scales of Attainment: Division 2, Form A
Standard Graduation Examination—Form A (Partly oral)

2. Achievement Tests for High School Pupils

American Council Alpha Spanish Test—Form A, parts I and II
Cooperative French Test—Form 1936

Cooperative French Test: revised series, advanced—Form P
Cooperative Latin Test: revised series, elementary—Form O
Cooperative Latin Test: revised series, advanced—Form P
Cooperative Plane Geometry Test: revised series—Form O
Cooperative Algebra Test: revised series—Form P
Mitchell Objective Tests for Dodge's New Biology
Sones-Harry High School Achievement Tests—Forms A and B. (A series of tests in high school subjects.)
Scholastic Aptitude Tests for the College Entrance Examination Board. (Given only under the auspices of the Board.)

A fairly comprehensive measurement of a whole school may be obtained by the use of (a) the New Stanford Achievement Tests in grades four to nine; (b) the Standard Graduation Examination in the eighth grade at the end of the year to test fitness to enter high school; and (c) the Sones-Harry High School Achievement Tests in the high school. Pupils who plan to go on to college may apply to the College Entrance Examination Board which now offers its tests in braille. Teachers who have the time and interest to do further testing may well use any of the other tests listed or adapt still others for their special needs, following the suggestions given in Chapter XIV. Many tests may be given with little change by presenting the material orally, a method which has been extensively used in our adaptation of the Standard Graduation Examination.

3. *Diagnostic Tests and Remedial Exercises*

A modification of achievement testing which makes an especial appeal to teachers is the so-called "diagnostic test" which may point the way to remedial work with individuals. Of course, any of the standard tests may yield data of diagnostic value through studies of the types of errors made. But the specially constructed diagnostic test seeks to assist the teacher in putting her finger directly upon the process, element or factor in a school subject which is causing particular difficulty for the individual pupil. An account of the use of diagnostic tests at the New York Institute for the Education of the Blind may be found in Chapter 27 of *Education of the Blind* (New York: World Book Company, 1940, p. 436).

Wrenn Stanford Study Habits Inventory (No braille)
Gates-Russell Diagnostic Spelling Test (Oral)
Ayres' List of One Thousand Most Frequently Used Words
Schorling-Clark-Potter Arithmetic Tests
Schorling-Clark-Potter Instructional Tests in Arithmetic for Pupils of Varying Abilities
Rinsland-Beck Natural Test of English Usage
Pressey Diagnostic Tests in English Composition
McCall-Crabbs Diagnostic Reading Manuals
Regents' Examinations in Reading
Gates-Peardon Remedial Reading Books (Oral, no braille)
Strang Study Types of Reading Exercises (Oral, no braille)
Durrell Remedial Reading Exercises
Tests in Everyday Reading (American Education Press)

B. Intelligence Tests in Schools for the Blind

The Binet-Simon intelligence tests had been in use in America for only a few years when their value for the classification of blind children was recognized by R. B. Irwin, then Supervisor of the Department for the Blind in the Cleveland public schools. In the summer of 1914 he visited H. H. Goddard, at Vineland, New Jersey, to discuss the question of adapting these tests for use with children without vision. Taking Goddard's translation of the 1911 edition of the Binet scale as a basis, they struck out those tests which could not be given without the aid of vision, made additions from various sources, and arranged their whole collection of tests in year groups according to Irwin's judgment of the abilities of blind children. The tests were at once put to use in the Ohio State School for the Blind by T. H. Haines who recast them in point scale form, publishing in 1916 his results with directions for the use of the tests in *Mental Measurements of the Blind: A Provisional Point Scale and Data for a Year Scale.* Soon afterward W. B. Drummond tried out the tests with 133 children in various schools for the blind in England and Scotland and published his "A Provisional Point Scale for the Blind" in the *Edinburgh Medical Journal,* 1920, 24, pp. 232-247, 307-323. In Austria, K. Bürklen made an independent adaptation of tests for blind children, depending largely upon Bobertag's use of the Binet tests, publishing his results in the *Zeitschrift für das österreichische Blindenwesen,* V, 1918, pp. 959-965 and VIII, 1921, pp. 1438-1440.

Group intelligence tests have also been used occasionally in schools for the blind, and since they can be administered by teachers they furnish a convenient survey of the more general abilities of the pupils in a grade to compare with their achievements in the subjects they are studying. Directions for giving the Pressey Group Point Scale and the Pressey Cross Out Tests were published in the writer's Manual for Self-Surveys in 1921, directions for the Otis Classification Test appeared in *The Teachers Forum* in 1931 and directions for the Sangren Information Tests for Young Children and the Kuhlmann-Anderson Group Intelligence Test in *The Teachers Forum* in 1938 and 1939. All these tests show fairly satisfactory correlations with the individual tests which take much more testing time and have to be given by trained testers, and thus serve as a secondary source of information upon the intelligence of blind children.

Systematic routine testing was started in two American schools for the blind in 1916 and within a few years more than 1100 blind children in ten residential schools had been individually tested. In 1916 the Stanford revision of the Binet tests was published and soon became the standard method of measuring the intelligence of seeing children. Realizing the advantage of bringing our tests into harmony with those for the seeing, the writer prepared and distributed in 1923 his *Scissors and Paste Guide,* an instruction book made by pasting into the Terman Guide a number of typed slips covering such changes as seemed necessary to adapt the tests for use with the blind. The arrangement of tests was based upon a careful, though incomplete, statistical study of passes and failures by age groups, supplemented by the judgment of the psychometrists who had used the tests continuously since 1916. Irwin had very early realized that some of his tests were unsuitable and that others were probably placed in the wrong year groups; Haines and Drummond had both been much impressed with the importance of degree of vision and the probable differences in mental imagery according to the age at onset of blindness, and had based their arrangements of the tests upon the results of the comparatively small number of pupils who had been totally blind from birth or early infancy. The writer was inclined to stress the practical need for a scale which would measure all of the children who came to schools for the blind, as well as the advantage of comparing them with seeing children of the same ages. His experience had led him to minimize the importance of the age at onset and the degree of blindness.

The 1923 Guide was widely distributed and seems to have served its purpose fairly well. But too little acceptable material was then at hand to provide six tests for each of the year groups, and quite a number of tests had been put into year groups later than those in which Terman had located them for use with the seeing, in order to get a scale which would yield a normal distribution of intelligence quotients among the blind. To obtain additional material, various other test series were examined, and a considerable number of items which seemed feasible for use with the blind were assembled and tried out with 418 pupils in residential schools. By the end of 1929, 746 more children had been tested with the 1923 Guide and it seemed wise to make a third revision. With the new material accumulated it was then possible to give a full complement of six tests in each year group with some alternates, and the study of passes and failures justified an age grouping of tests much closer to Terman's. Also it seemed time to print a more convenient book than the *Scissors and Paste Guide* of 1923.

The distribution of the 1930 Guide resulted in a much wider use of intelligence tests with the blind, for not only was a program of regular testing and retesting started in a considerable number of residential schools, but many clinics and institutions for mental defectives, as well as braille and sight-saving classes in the public schools now made regular use of our Binet adaptation. In general both the 1923 and the 1930 adaptations produced fairly normal distribution curves when total unselected school populations were tested, and retests after two or more years showed a reasonable constancy of the I.Q. We had looked forward to obtaining an average I.Q. of 100 in each school tested with the 1930 adaptation; actually the average I.Q.'s in sixteen different schools reporting from 1930 to 1940 ranged from 108 to 92. Whether this means that some schools draw their pupils from better intellectual stock than others, or indicates local differences in the reception and retention of pupils in residential schools, or points to inequalities in leniency of scoring by testers of different training, we cannot at present determine. An extended study of the pupils entering two large eastern schools, where the directors have exercised a fairly liberal policy towards pupils of modest intellectual promise, has discovered little change in the average I.Q. during the period from 1915 to 1940, using our three adaptations of the Binet tests successively. In these two schools the median I.Q. curve oscillates from year to year slightly above or below I.Q. 90 as a center. For our whole group of sixteen schools, involving tests of 2192 pupils with the 1930 adaptation the average I.Q. was 98.25, S.D. .1970.

The two commonest criticisms of our adaptations of the Binet tests have been: (1) that no thorough-going standardization of the tests for the blind has ever been published; and (2) that nobody knows just what value to give to the resulting I.Q., i.e., how it compares with an I.Q. obtained from Binet tests of seeing subjects. We are now attempting to correct both deficiencies in our fourth revision, the 1941 adaptation.

1. Steps in the Adaptation and Standardization of a Binet Series for the Blind

The 1914 adaptation was a common-sense modification of the 1905, 1908 and 1911 Binet-Simon series, in which Irwin and Goddard simply omitted the tests which could not be taken without vision, introduced a few new tests which looked promising, extended the use of certain tests into additional year-groups and moved some tests into year-groups where they seemed more suitable on the basis of Goddard's experience in testing and Irwin's knowledge of the blind.

The 1923 *Scissors and Paste* adaptation was based upon a study of passes and failures in nearly 1200 tests, checked by comments of the psychometrists who had used the tests in various residential schools for the blind. When work was begun upon the 1930 adaptation we had data from an additional 1600 tests, and comparisons were made with Terman's 1916 figures and our 1923 figures. Charted by per cent passing in each age group we get a picture in which the two curves for the blind follow a course similar to that for the seeing, but at least ten per cent below it. A similar curve based upon 2234 tests with the 1930 adaptation showed only about a 5 per cent deficiency; but while the average per cent passing by age groups was fairly satisfactory, the curve of per cent passing in the individual test items was still quite irregular. In general the 1930 adaptation seemed to work fairly well in the classification of pupils, but there were many surprises in the I.Q.'s attained by certain individuals and in the changes in I.Q. noted upon retesting.

The 1941 adaptation will consist of an attempt to answer the following questions: (a) Has the 1930 adaptation been a fairly *valid* instrument which is worth working over and revising again? In general we feel that our answer must be an affirmative one, because of the relatively high positive correlations obtained with other measures of intellectual achievement, as well as the general approval of the tests by teachers and testers. The Otis Classification Test—Form A, part 2, gave rank order correlations with M.A. obtained with the 1923 adaptation of +.76 for 210 pupils in the Perkins Institution and the Pennsylvania Institution for the Blind, and +.77 for sixty-four pupils in the Western Pennsylvania School for the Blind. The Stanford Achievement Test yielded product moment correlations of +.75, +.83, +.83, and +.95 in four schools with from sixty-nine to 103 pupils. The Kuhlmann-Anderson Group Intelligence Test gave somewhat lower product moment correlations (+.56, +.57, and +.69) in three schools with from thirty to 102 pupils. There is, however, some question as to whether the mechanical difficulties of this test when given in braille have been satisfactorily overcome and whether it is not as much a measure of facility in tactual reading as a measure of intelligence. (b) Has the 1930 adaptation been fairly *reliable?* The evidence from retesting seems to justify an affirmative answer to this question also. (1) For the *test as a whole* we find a rank order correlation by I.Q.'s of +.95 for seventeen pupils retested at the Perkins Institution after six months; a product moment correlation of +.87 for 130 pupils retested at the New York State School for the Blind after four months; a product moment correlation of +.85 for fifty-three pupils retested at the Pennsylvania Institution after from one to twelve months, of +.79 for forty-nine pupils retested at the same school after from thirteen to twenty-four months, and similar results for later retestings; product moment correlations of +.79 for 409 pupils at the Perkins Institution and +.85 for 587 pupils at the Pennsylvania Institution when their first and second tests are correlated regardless of the time interval between tests. (2) When the *individual test items* are correlated on retesting we find that at the New York State School for the Blind, twenty-six of the fifty-six tests used showed retest correlations of +.90 or above, while only eight of the tests showed correlations below +.60; at Perkins Institution, on retesting within twenty-four months, nine of the fifty-six tests used showed retest correlations of +.90 or above, thirty-eight tests showed correlations of +.60 or above and eighteen tests showed correlations below +.60; at the Pennsylvania Institution on retesting within twenty-four months twenty-six tests showed correlations of +.90 or above, thirty-eight showed correlations of +.60 or above and seventeen tests showed correlations below +.60. Apparently a large per cent of the tests are reliable; some will have to be modified or dropped. (3) A further measure of reliability was obtained through the calculation of tetrachoric correlations of each test item with the M.A. obtained from the whole battery of tests, in seven schools. In general these correlations run high enough to be quite satisfactory. Only a few tests will have to be omitted as a result of this check-up. For five of the seventy-six tests studied, correlations of +.90 or above were obtained, for sixty-seven of the seventy-six tests, correlations ran from +.60 up, and for only twelve were the correlations below +.60. Tetrachoric "intertest" correlations within each year-group were also calculated to find whether there were any test items which unnecessarily duplicated each other by apparently measuring the same factors. In each year-group these correlations showed a wide range—from +.18 to +.66 in the sixth year tests, for instance. The average of the whole collection of intertest correlations was +.51. The relatively small number of tests showing intertest correlations in the 80's and 90's will naturally be omitted in our revision: they are mainly concerned with tests in which fine distinctions in the meaning of words are demanded. (4) As a measure of the *constancy of the I.Q.*, sixty-eight pupils at Perkins Institution who had been tested five or more times were selected for special study. These pupils were first divided into five ability groups on the basis of their average I.Q.'s at different periods of testing, 70-79 I.Q. being classed as *very low*, 80-89 classed as *dull*, 90-109 classed as *average*, 110-119 classed as *superior*, 120 and above classed as *very superior*. All the curves for the individuals of each group were assembled on a single sheet and I.Q.'s interpolated for the years in which they were not tested; then "limited range" curves were made by combining the individuals who were tested through the same span of years. The 100 I.Q. line was drawn in for comparison. Surprisingly consistent limited range curves resulted. The *very low* group, for instance, involving ten individuals, furnished four curves all of which followed practically the same course, starting with about two years retardation at C.A. 7, and gradually bending over to three years retardation at C.A. 10, and five years retardation at C.A. 16. The *dull* group, consisting of fourteen individuals, yielded four limited range curves which run along close together, starting with a retardation of less than a year at C.A. 6, bending slightly for a retardation of nearly two years at C.A. 12, and four years retardation at C.A. 16. The *average* group, composed of twenty-three individuals, yielded six limited range curves which clustered about the 100 I.Q. curve through the early years, with a tendency for two of the curves to rise above the normal curve from C.A. 13 onward. The *superior* group, consisting of thirteen individuals, yielded three curves which showed a consistent acceleration, starting at about one year at C.A. 7, and attaining two or more years acceleration in the early 'teens. The *very superior* group, consisting of eight individuals, yielded three curves with similar progressive acceleration from a two years' superiority at C.A. 7 to a four years' superiority at C.A. 14 and then somewhat less. In general, these curves seem to indicate a very satisfactory constancy of the I.Q.: the normal group remains normal throughout its course; the superior groups tend to show greater superiority and the inferior groups greater inferiority as we advance from the lower to the higher C.A.'s. These results seem particularly gratifying considering the variety of factors which might affect the accuracy of the individual I.Q.'s—that through the years different testers were employed who had different training and might show variations in severity or leniency of scoring, that the tests were given at irregular intervals and interpolations made necessary, that only a limited number of cases was available so that chance factors like differences in the effect of the handicap of blindness and differences in the environment before and after blindness might have a large and unpredictable influence on the results. A further proof of the constancy of the I.Q. may be obtained from the fact that the critical ratios—obtained by dividing the difference of the means by the sigma of the difference—run quite low, i.e., in fifteen critical ratios calculated from the retest data only two are high enough to show a significant difference between test and retest, the other thirteen ratios all being below 3 and many of them much below 3.

2. *How Intelligent Are the Blind? How Does a Hayes-Binet I.Q. Compare with a Stanford-Binet I.Q.?*

Great caution must be used in generalizing about the intelligence of the blind, since determining this has not been a major aim in our work. We needed tests to classify children coming to schools for the blind and the practical issue had to take precedence over the theoretical. We have now, however, a certain amount of indirect evidence which will be checked with direct evidence when material accumulates from the projected use of the L and M scales of the Terman-Merrill revision, selecting only those tests which can be used with the blind practically without change, and in the same year-groups in which they are scored for the seeing. Other evidence will come from the use of the Brown I.J.R. Test for the Visually Handicapped and the Wechsler-Bellevue Adult Intelligence Tests, both series having been standardized on the seeing.

In so far as the Binet tests measure functions similar to those involved in school work, one might reasonably expect somewhat lower I.Q.'s than with the seeing, since blindness accentuates various well-known causes for school retardation. We are accustomed to explain educational retardation by any one of a considerable number of accidental causes such as illness in infancy, physical accidents, malnutrition, lack of sleep, unwise treatment in the home whether characterized by over-indulgence or excessive restraint, emotional conflicts due to a sense of inferiority or an unhappy home life, belated admission to school, irregular attendance, inefficient teaching, etc. Whenever blindness increases such hazards—and people in work for the blind will say that this occurs very frequently—we may look for their effects in delayed development and backwardness in school work. As a matter of fact we do find an age-grade retardation averaging from two to three years in most residential schools for the blind, and extending to four years or more in some schools or grades.

Our indirect evidence points to a similar retardation in the development of intelligence. (1) In our achievement tests, which show a high correlation with our Binet tests, blind children who average two or three years over-age for their grades, test just about at the seeing levels when we give them the extra time needed for reading braille. (2) A comparison of the I.Q.'s obtained when 300 pupils tested with the 1923 adaptation were scored in two ways, indicated a lower attainment for the blind. In this study two I.Q.'s were calculated for each individual, one I.Q. from the test items in the age groups in which they appear in the 1916 Stanford-Binet, which we called the "seeing I.Q.," and another I.Q. calculated from the same test items but in the changed age-groups in which they appear in the 1923 adaptation for the blind, which we called the "blind I.Q." The average "seeing I.Q." was +.89, S.D. .1821; the average "blind I.Q." was +.92, S.D. .1910. The two I.Q.'s showed a rank order correlation of +.84 ±.011. (3) Various tests of blind children's vocabularies point to a marked retardation. Terman's group vocabulary test was used with more than four hundred blind children in our early testing and showed a definite annually increasing retardation of one year for the eleven-year-olds, three years for the thirteen-year-olds and four years for the sixteen-year-olds. The individual vocabulary test of the Binet series showed a similar retardation. Terman, in his 1937 revision, states that his vocabulary test "agrees to a high degree with the mental age rating on the scale as a whole;" so we may conclude that the deficiency which blind children show in vocabulary gives further evidence of a low level of intelligence. Similarly in the Word Meaning test, which is number two of the Stanford Achievement series, the attainment of blind children runs about ten per cent below seeing standards when the blind are grouped by mental age. (4) Blind children tend to test lower than the seeing in all the Binet items which one would classify under thinking or reasoning. In the comprehension tests and in the tests calling for differences and similarities we find an increasing retardation, one or two years in the lower age groups and four years in the 'teens. Samples of comprehension tests are: "What must you do when you are sleepy?" at four years; "What's the thing to do if it is raining when you are out playing?" at six years; "What's the thing for you to do when you have broken something which belongs to someone else?" at eight years; and "What ought you to say when someone asks your opinion about a person you don't know very well?" at twelve years. "What is the difference between an orange and a ball?" is asked of the seven-year-old; "In what way are iron and silver alike?" is a ten-year test; "In what way are a snake, a cow and a sparrow alike?" is asked of the twelve-year-old. Blind children test just about at age when eight-year-olds are asked to make a sentence containing two words, such as *ball* and *play;* they fall two years behind when at ten years they are asked to make a sentence containing three words such as *work, money, men.* Still more obvious thought questions are the following: The problematic situations presented to nine-year-olds, such as, "A little boy is coming into his home crying, and holding a paper bag with a hole in it. What has happened?"—the absurdities tests of the twelve-year group such as, "An engineer said that the more cars he had on his train, the faster he could go. What is foolish about that?"—such fourteen-year tests as the interpretation of fables, the completion of analogies, such as, "Ship is to water as train is to what?"—the problem questions, such as, "A man who was walking in the woods near a city stopped suddenly, very much frightened, and then ran to the nearest policeman, saying that he had just seen hanging from a limb of a tree a ——— a what?"—the items in arithmetical reasoning, the request to tell the time if the hands of the clock were reversed from their present positions, the demand for the three main differences between a president and a king; the sixteen-year tests in which pupils are asked to give the general meaning of four phrases like "Drinking the sea dry," and "Touching the end of the rainbow," are required to tell how many boxes are involved in various combinations of boxes which contain each other, are tested for their ability to explain the meaning of proverbs such as, "Every path has its puddle," and "Rome was not built in a day;" the eighteen-year test in which pupils are asked to listen to a fairly abstract paragraph and give the main thoughts expressed. In all these tests involving reasoning, fairly normal curves of progress from year to year have been obtained, but the level of these curves is from two years below the seeing in the earlier tests, and three or four years below in the fourteen-year tests, to still greater retardation in the higher years. In general, then, one must conclude that the Binet tests of reasoning, which have been used with more than 3000 blind children, indicate a retardation of about two years in children below ten years of age, four years in those who are fourteen, and a still greater retardation in those in their late 'teens. A similar conclusion may be drawn from the results of *group* tests of reasoning, which have been given to several hundred blind children. There would seem to be no possible doubt that blind children are retarded in reasoning as much as, if not more than, they are retarded in school progress, possibly from the same causes.

Applying this evidence of retardation to a list of tests selected from forms L and M of the Terman-Merrill revision which seem feasible for use with the blind, we may expect a retardation of at least one year in half the tests for years IV to VII, a retardation of at least two years in half the tests for years VIII to XIV, and a retardation of four years in many of the adult tests, especially in those involving vocabulary and reasoning. How this retardation will figure out in lower I.Q.'s for the blind must wait upon a thorough trial with these tests. Further evidence of the intelligence status of the blind will be sought through the use of the Wechsler-Bellevue Adult Intelligence Scale with blind adolescents. Fortunately Wechsler's Verbal Series of five tests and his vocabulary test can be used practically without change.

Finally, mention should be made of Brown's Institute of Juvenile Research Tests for the Visually Handicapped. This is a point scale developed for use with children having any degree of vision from normal to totally blind. Its tables of norms, however, are based upon the attainment of seeing children, so it should ultimately yield direct evidence upon the relative abilities of the seeing and the sightless. Its most obvious use is in sight-saving classes and in clinics, but it has been used successfully in a few residential schools for the blind.

How intelligent are the blind? We have no scientific evidence about the adult blind, except in so far as those are involved who were tested during their course of study in a residential school. But the constancy of the I.Q. would lead us to expect our graduates to remain in the same general group through life—superior, average or inferior. We should say the same about people who lose their sight after school days: blindness becomes a very serious handicap in social intercourse and makes it much more difficult to keep up with events, for even those who learn to read braille have at best a slow and limited tool to work with. About blind school children we can speak with more authority on the basis of our extensive testing: both the direct and the indirect evidence seem to point to at least a two-year retardation in school work and in the abilities our intelligence tests measure. With the improvement and extension of our tests more definite statements may be made. Our immediate program includes a 1941 Hayes-Binet adaptation standardized upon the blind in residential schools yielding a "blind I.Q." for classification purposes within the schools; the use of the five verbal tests and the vocabulary test of the Wechsler-Bellevue Adult Intelligence Scale with children from fourteen years upward and with blind adults; some use of the Brown I.J.R. Tests for the Visually Handicapped which were standardized upon the seeing; and a selection of tests from the L and M forms of the Terman-Merrill revision of 1937 which may be used with the blind without change. We hope ultimately to construct comparison tables to translate the scores obtained in any one test into equivalent scores in each of the others, and then we can give a more explicit and satisfactory answer to our question, "How intelligent are the blind?"

Appendix A

HISTORY AND CHRONOLOGICAL BIBLIOGRAPHY OF ACHIEVEMENT MEASUREMENTS OF CHILDREN IN RESIDENTIAL SCHOOLS FOR THE BLIND

I. THE FIRST TEN YEARS

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Hayes, S. P. *Ten Years of Psychological Research in Schools for the Blind.* Philadelphia, Pennsylvania Institution for the Instruction of the Blind, 1927, 16pp.

II. THE SECOND TEN YEARS; GRADUAL INCREASE OF INTEREST IN TESTING

1927–32 Establishment of an experimental school at Perkins Institution in co-operation with the American Foundation for the Blind.

1928 Maxfield, K. E. *The Blind Child and His Reading.* New York, American Foundation for the Blind, 1928, 215pp.

Establishment of *The Teachers Forum for Instructors of Blind Children,* published five times a year by the American Foundation for the Blind.

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Appendix B

History and Chronological Bibliography of Intelligence Measurements of Children in Residential Schools for the Blind

1914 Adaptations of the Binet-Simon tests at Vineland, New Jersey, by Robert B. Irwin and Dr. H. H. Goddard.

1916 Haines, T. H. *Mental Measurements of the Blind; A Provisional Point Scale and Data for a Year Scale.* Princeton, Psychological Review Co., 1916, 86pp.

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1919 Haines, T. H. "Report of New Cases and More Reliable Age Norms of Intelligence by the Point Scale for the Blind." *Journal of Educational Psychology*, X, 1919, pp. 165-167.

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Appendix C

RESULTS OF THE USE OF THE 1930 HAYES-BINET INTELLIGENCE TESTS IN 17 RESIDENTIAL SCHOOLS FOR THE BLIND

School	Number tested	I.Q.'s obtained		Pupils with I.Q. of 120 and above		Pupils with I.Q. of 70 and below		Dates of testing
		Mean	S.D.	Number	Per Cent	Number	Per Cent	
1	105	108.1	17.78	8	7.6	6	5.7	1934–35
2	42	105.95	16.08	5	11.9	3	8.	1934–35
3	152	105.8	17.58	15	10.	6	4.	1936–37
4	93	105.5	16.52	13	13.9	4	4.3	1934–35
5	207	105.1	20.41	29	14.	21	10.	1934–35
6	108	104.9	18.75	20	19.	5	4.8	1938–39
7	149	99.5	19.18	20	13.4	13	8.7	1938–39
8	239	99.5	15.24	30	12.5	18	7.5	1938–39
9	220	98.77	22.24	23	10.4	26	11.8	1938–39
10	163	98.7	17.47	10	6.	16	9.8	1934–35
11	135	97.87	16.10	10	7.4	8	5.9	1939–40
12	111	97.64	19.96	13	11.7	11	10.	1938–39
13	127	95.2	22.62	21	17.3	19	14.9	1932–39
14	75	95.2	18.97	5	6.7	7	9.3	1934–35
15	270	93.7	17.	13	4.8	24	8.9	1934–35
16	90	92.5	19.03	4	4.4	15	16.6	1938–39
17	86	92.	21.48	7	8.	16	19.	1937–38
Total	2372			246	10.3	218	9.2	

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